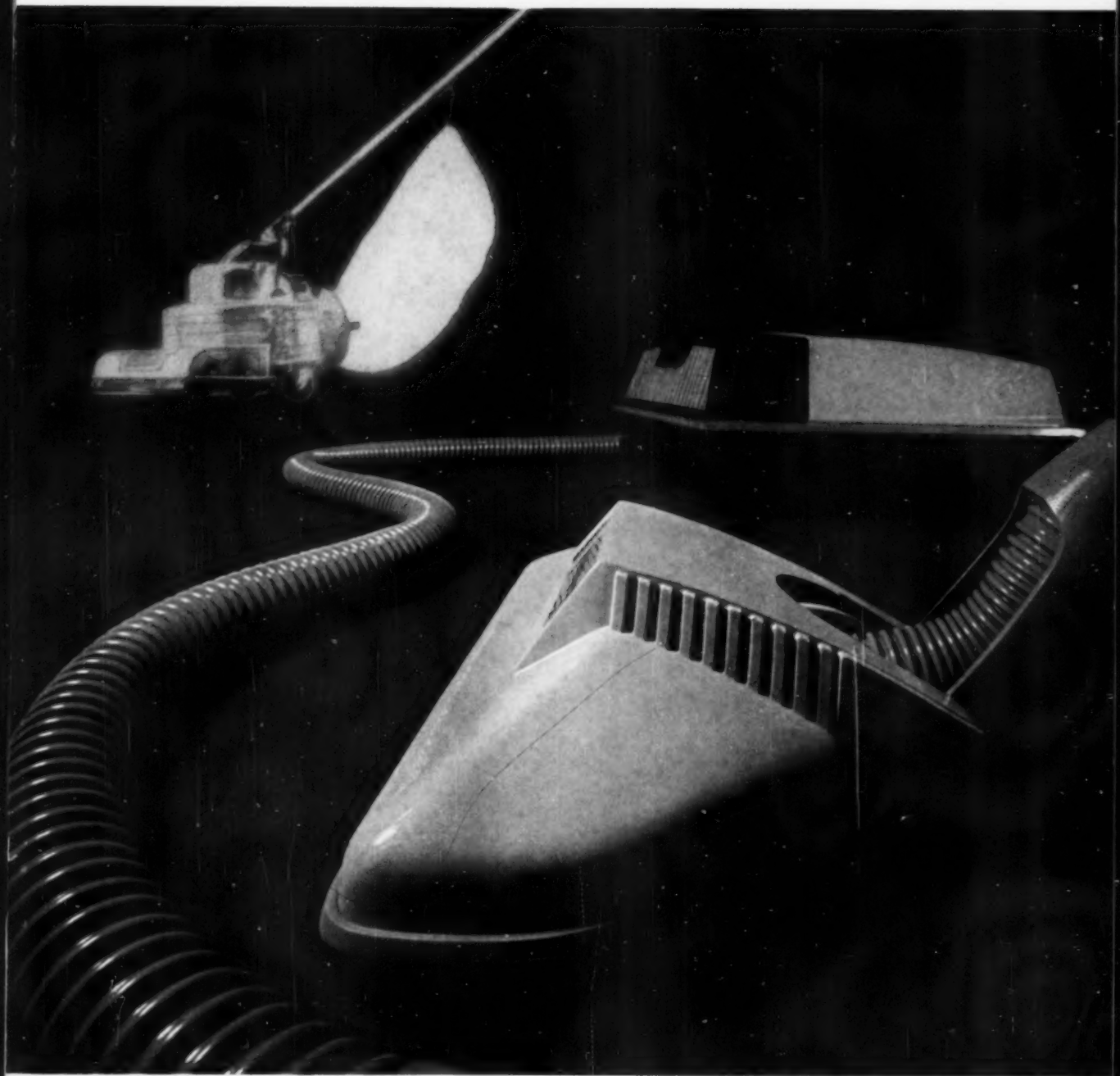
# MODERN PLASTICS

JULY 1960



PHOTOGRAPHED FOR MODERN PLASTICS BY RUDY MULLER

**PLASTICS IN THE PRODUCT REVOLUTION:** The vacuum cleaner *p. 106*

**Ten predictions for the sixties** *p. 86*

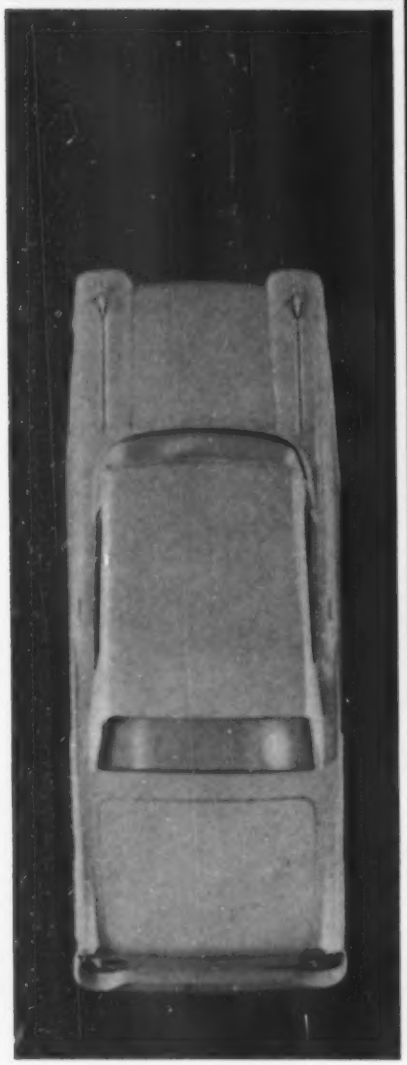
**New markets for the exciting pregregs** *p. 81*

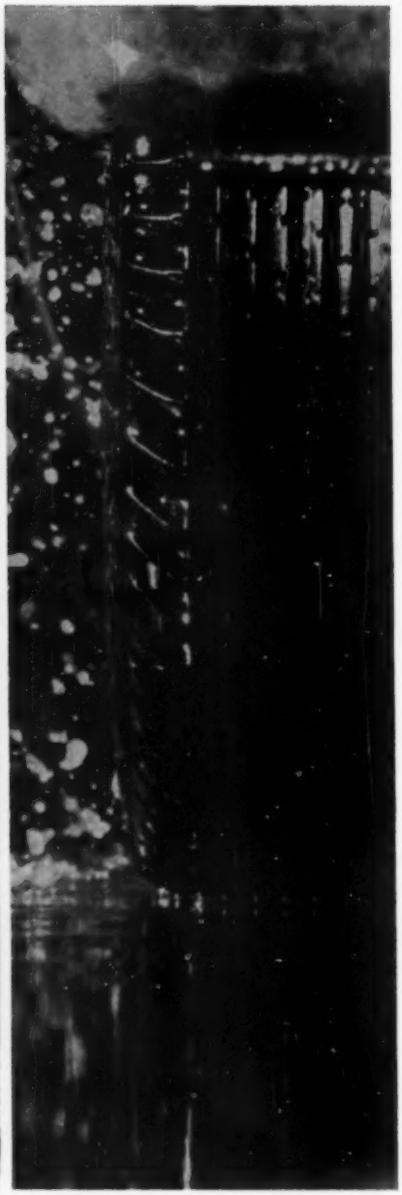
**Where are the polycarbonates going?** *p. 102*

**How to extrude polypropylene film** *p. 111*

**Tips on fluidized bed vinyl coating** *p. 124*

# THIS IS CHEMAGINATION





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# MODERN

## THE PLASTISCOPE

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## GENERAL

**Prepregs** . . . . . 81

Out of the missile and aircraft programs have come a range of materials with tailor-made muscles. Although still plagued with problems of standards, these materials have begun to carve out for themselves an important niche in the plastics industries. First applications were in the space field. Now, however, prepregs are moving into consumer markets in many critical applications. Here's what types are available, where they can best be used, how they are made and fabricated, and how much they cost.

**Ten predictions for the 60's** . . . . . 86

An authority on plastics markets and management takes a critical look into the future and comes up with prognostications that will be of vital interest to all those concerned with planning. What will plastics cost 10 years from now? What will happen to the custom molder? What will the new resins be? What changes can we expect in the supplier-customer relationship? How is processing research going to be changed to catch up with the potentials of polymer research? These are some of the questions considered and answered.

**What plastic is it?** . . . . . 88

The continued increase in the number of plastics materials has made it more important—and more difficult—than ever to devise a system which will permit manufacturers to identify the specific material of which a product is being made. Tapping, feeling, and burning can no longer do the job. Gatefold chart, suitable for wall mounting, provides a step-by-step procedure through which an unknown plastic product can be identified. These procedures, though relatively simple, require some equipment and chemicals.

**Burgeoning bead board business** . . . . 97

Approximately 250 million bd. ft. of polystyrene foam were sold in 1959. There are some who predict 1 billion bd. ft. by 1964. These foams go into insulation, building, flotation, and packaging and represent a resin consumption potential that may run into 100 million lb. a year. This second in our three-part series tells how boards are made and fabricated, what machinery is used, what it takes to get into this business, and how the various markets stack up in terms of consumption.

**Polycarbonates are starting to move** . . 102

Before there had been any announcement of full commercial polycarbonate resin production, over 200 commercial products made from this resin were already on the market! What's even more startling, the applications were based on a resin developmental-quantity price of $2.50. Now that full production is here and the price has been dropped to $1.50/lb., a minimum of 20 million lb. per year by 1965 is anticipated. Who are the producers? Where is the material going? How is it processed? What are the anticipated price trends? Here are the answers.

**Plastics in the product revolution: the vacuum cleaner** . . . . . 106

The metal monsters of the early days of vacuum cleaners were probably among the heaviest portable appliances the housewife had to contend with. Plastics made their first penetration as a means of lightening the burden. Since then much progress has been made. Today plastics are used extensively in most commercial units. What materials are involved and exactly where they are going is tabulated on detailed chart.

**Modern Plastics Executive and Editorial Offices:** 575 Madison Avenue, New York 22, N.Y. Please mail all correspondence, change of address notices, subscription orders, etc., to above address. Quotations on bulk reprints of articles appearing in this issue are available on request.

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# PLASTICS*

JULY 1960
Volume 37 Number 11


## • ENGINEERING


**Extruding polypropylene** . . . . . **111**

Both chill roll and water-bath techniques can be used to extrude polypropylene film. Better balanced strength properties are obtained with the chill roll process. Stiffer and glossier films can be produced by the water-bath technique. Effect of air gap in the first and of water temperature in the second are fully analyzed. Factorial experiments on which these findings are based are discussed in detail, including the reasoning behind them. *By A. R. Gilden and W. J. G. McCulloch.*

**Fluidized bed coating with vinyl** . . . . **124**

At first glance the fluidized bed coating technique seems a simple process: dip a heated metal object into finely divided, powdery material, withdraw, and the object is coated. But the apparent simplicity can be misleading. Desirable coating can be obtained only under carefully controlled operating conditions. The effect of oven operating temperature, surface/volume ratio of substrates, and plasticizer level on the finished coating are outlined and optimum processing conditions indicated. *By R. J. Borsh.*


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**Stabilization of mixed polyamides** . . . **142**

While tough and abrasion resistant, polyamide resins tend to degrade on prolonged exposure to light and elevated temperatures, losing those properties for which they are most highly valued. This article presents the results of experimental work conducted on five mixed polyamide compositions and their effectiveness in stopping this degradation. The subject of heat stability, which represents a formidable problem, is considered in detail. *By M. M. Epstein and C. W. Hamilton.*


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## Coming Up . . .

Literally millions of different film laminations can be produced from the 30 plastic and non-plastic film materials currently available. What the most commonly used laminations are, where they are used, and how much they cost is the subject of our August lead. . . . Special preview of macroPlastic, plastics exhibition and conference to be held in Utrecht and Amsterdam, Netherlands, Oct. 1960, including exhibitors. . . . First in a series of engineering articles on film winding. . . . How diallyl phthalate is going to compete with phenolics and melamine in the decorative laminate field. . . . Differential thermal analysis, our August Technical Section lead, will show how this research tool can be applied to polymers. . . . Also in the works: How vinyls are doing in building applications. . . . Special color effects—fluorescence, glitter, etc. . . . The economics of large thermoformed pieces. . . . Design for vacuum metallizing. . . . Molds for blow molding. . . . The economics of dip dyeing. . . . Annual plasticizer review.


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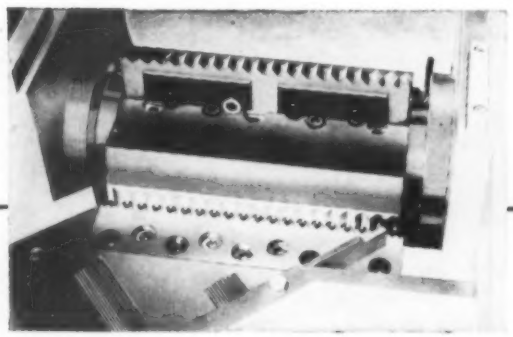

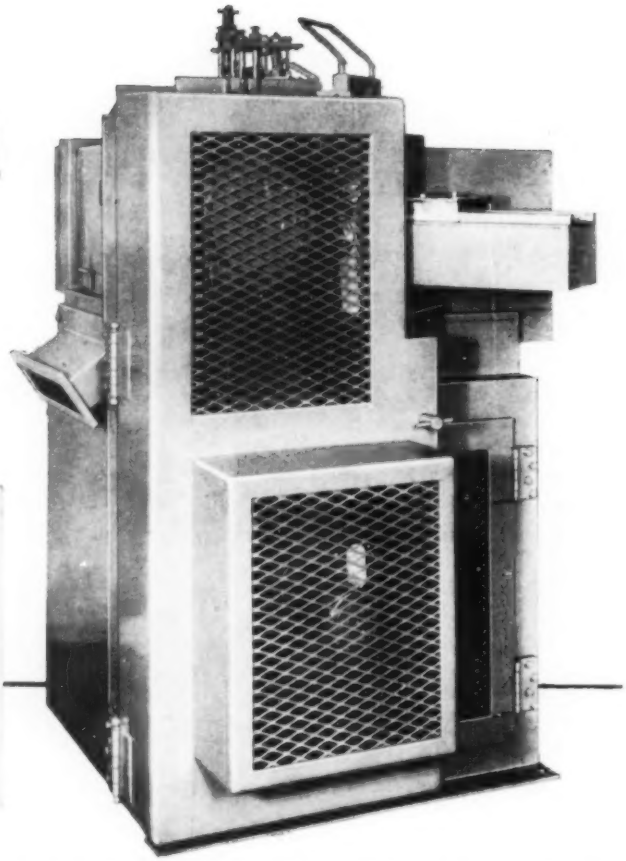

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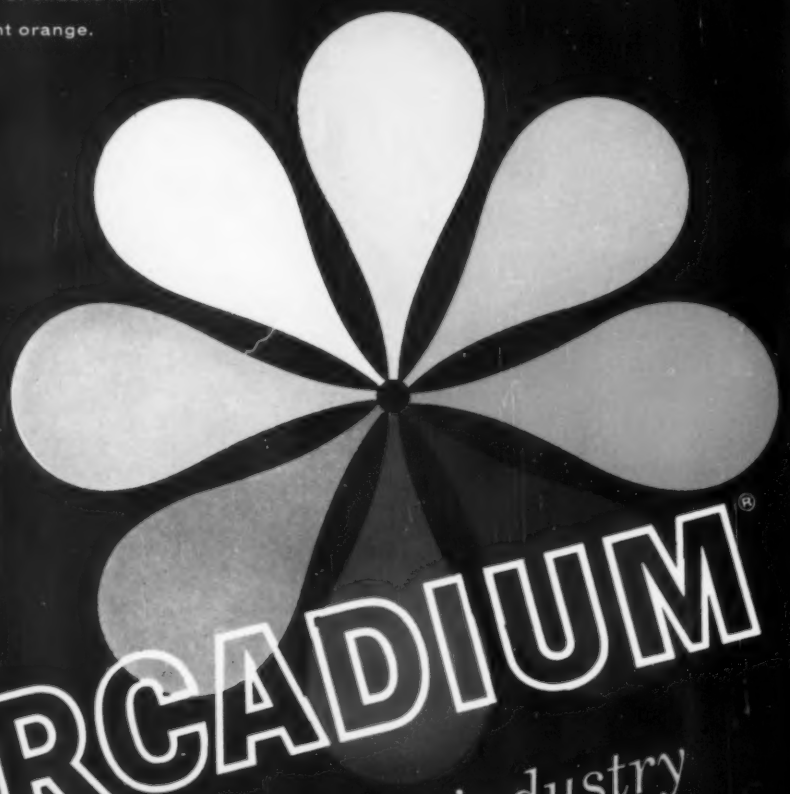

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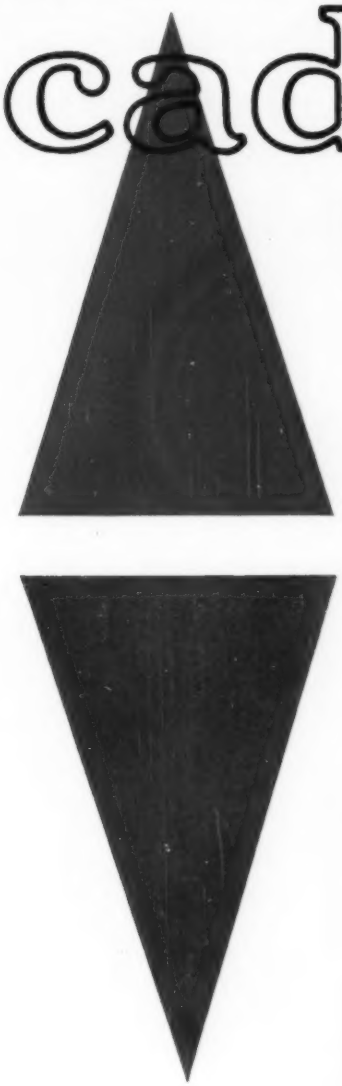

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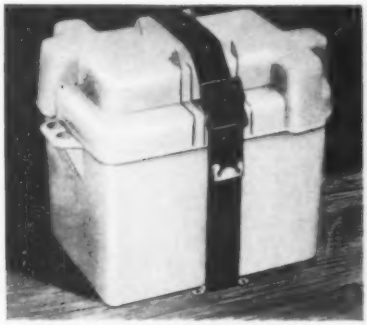

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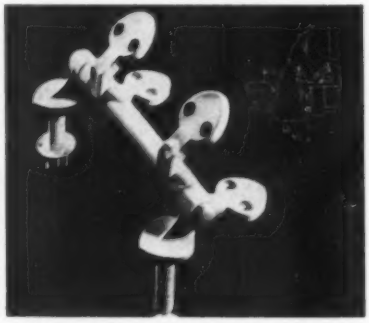

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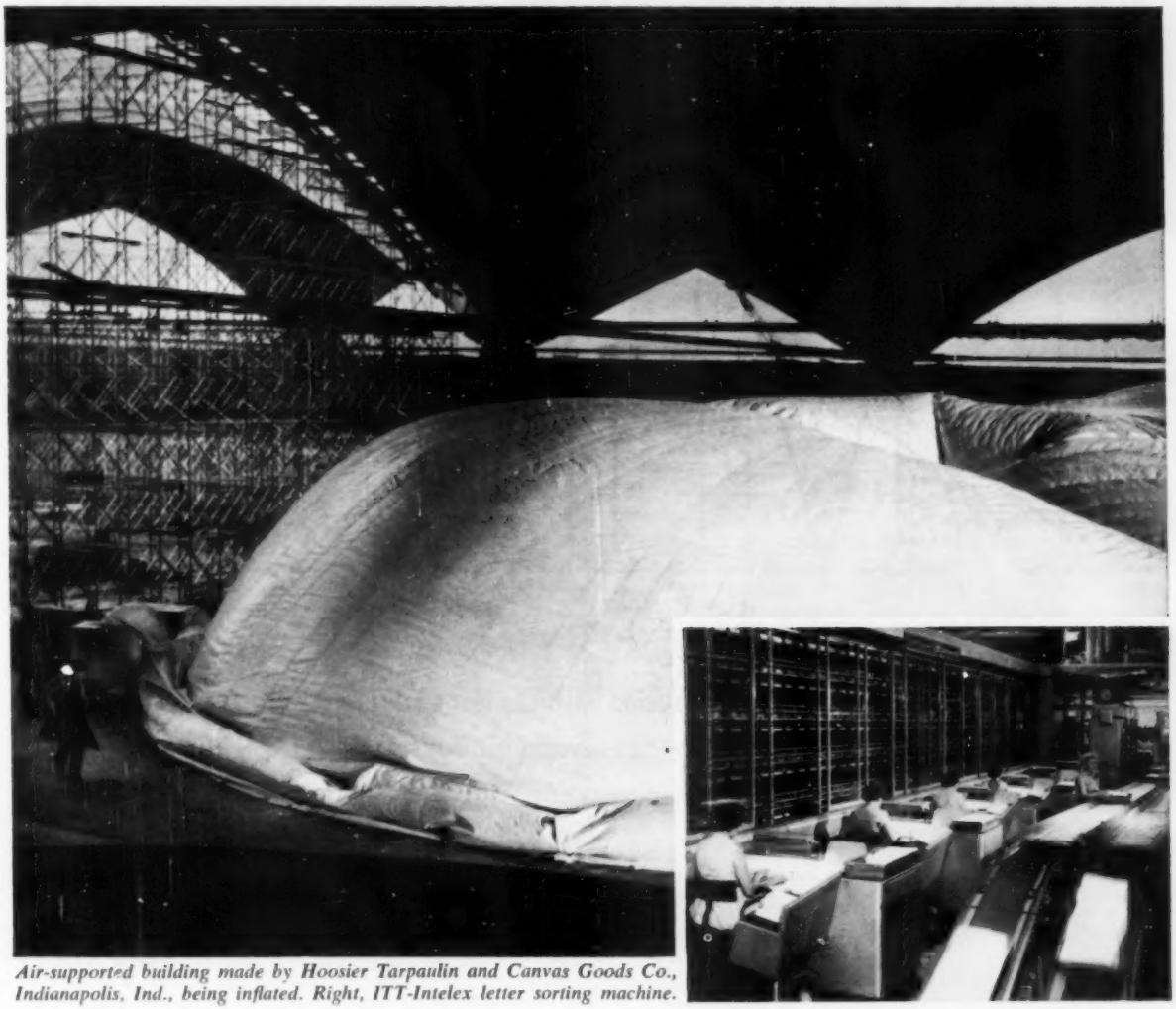

*Air-supported building made by Hoosier Tarpaulin and Canvas Goods Co., Indianapolis, Ind., being inflated. Right, ITT-Intelex letter sorting machine.*

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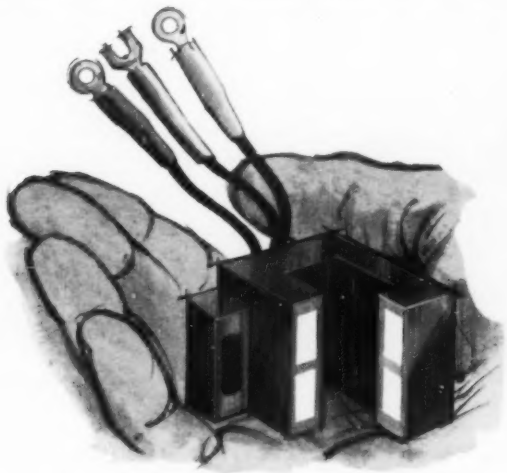

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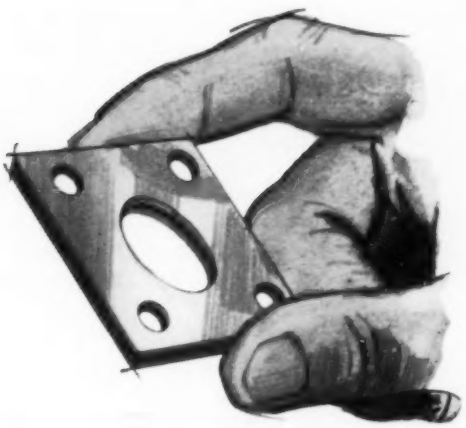
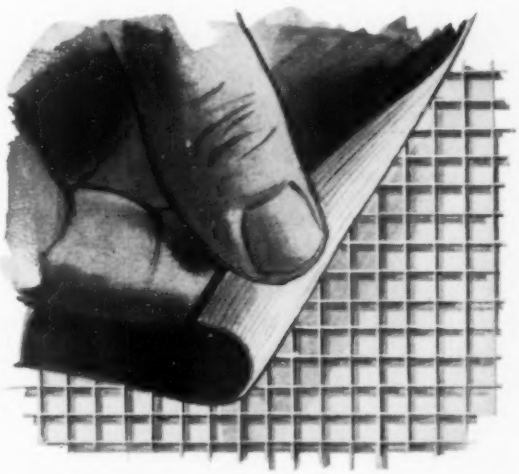


**IN LAMINATES** Glass-reinforced resins cured with PMDA retain good flexural and tensile strengths after 1,000 hours at 500° F.



**IN ADHESIVES** Epoxy adhesives cured with PMDA have good tensile-shear strengths even after 200 hours at 500° F.

DUPONT REG. U.S. PAT. OFF. **PMDA** (PYROMELLITIC DIANHYDRIDE)

*Price quoted is f.o.b. Gibbstown, New Jersey, for material in standard containers and is subject to change without notice.*

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

GOODYEAR

# Now...the quality of PLIOVIC dispersion resins in quantity!

**Good news!** The latest expansion of our Niagara Falls facilities is well underway and a new dispersion resin, PLIOVIC WO, has been added to the line.

**PLIOVIC WO** is the distinctively different, straight PVC resin offering these inviting advantages in both organosols and plastisols. Unusual pseudoplasticity. Excellent viscosity stability. Exceptional adhesion. Good heat and light stability. Low water sensitivity. Unusually low gelation and fusion temperatures. High strength and abrasion resistance.

**PLIOVIC AO** is the distinctively different copolymer vinyl resin with these well-established advantages in dispersions: Excellent dispersing characteristics. Wide plasticizer compatibility. Good viscosity stability. Gradual gelation. Low fusing temperature. Good physical properties.

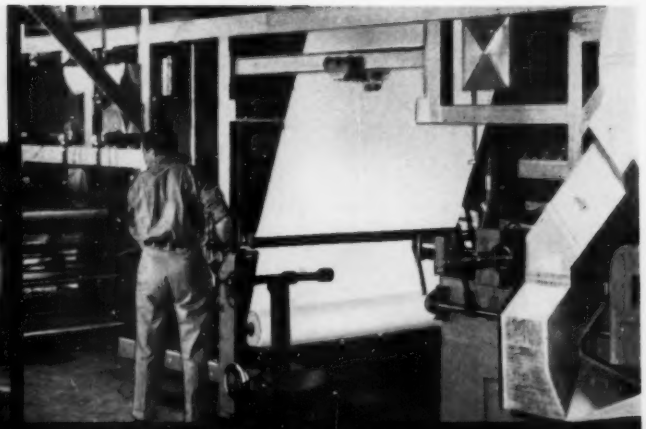
**Just how well** these unusual resins work can be seen in the experiences of the manufacturers whose products are described here. They're well pleased with their performance —will be even more pleased with their greater availability. You will, too. Full details on PLIOVIC WO and/or AO, including the latest *Tech Book Bulletins*, are yours simply by writing Goodyear, Chemical Division, Dept. S-9422, Akron 16, Ohio.

Lots of good things come from

GOODYEAR CHEMICAL

**EXCELLENT HOLD-OUT.** Dry, flexible coating with excellent surface. Low fusing temperature. These are the reasons why PLIOVIC WO is used in a coating on nylon for air-supported structures and in a range of coated fabrics for industrial, military, aircraft and marine use by a leading manufacturer.

*Photo taken through the courtesy of Cooley, Inc., Pawtucket, R.I.*

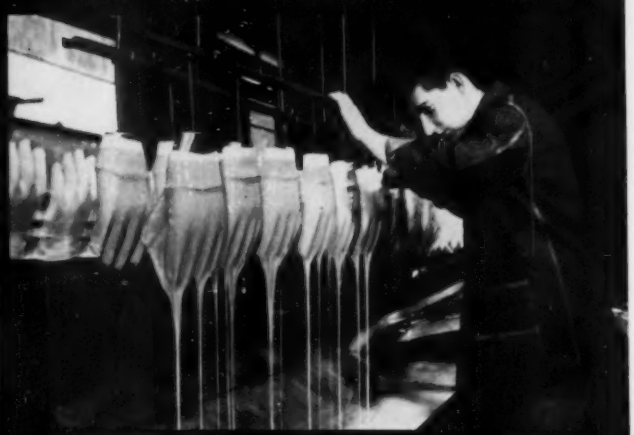


**LOW FUSION TEMPERATURE** that protects against a film's "debossing," the distortion of a printed pattern or damage to a synthetic fabric, plus excellent adhesion and flow characteristics that permit close control of strike-through are the properties that recommend PLIOVIC WO for film-to-fabric laminations.

*Photo taken through the courtesy of Lembo Machine Works, Inc., Paterson, N.J.*

**UNUSUALLY LOW** gelation temperature. Greater fluidity and depth of viscosity control. Better wetting characteristics. Easy processability. These are the properties that place PLIOVIC WO in a unique foot scraper mat.

*Photo taken through the courtesy of Miltron Corporation, Greenback, Tenn.*



**EXCELLENT RESISTANCE** to chemicals and abrasion plus other advantages in dip coatings. Excellent dispersion properties. Wide plasticizer compatibility. Low fusion temperature. Good adhesion. Good viscosity characteristics. These are the reasons why a leading name in work gloves uses PLIOVIC AO.

*Photo taken through the courtesy of Martins Ferry Glove Company, Uhrichsville, Ohio.*

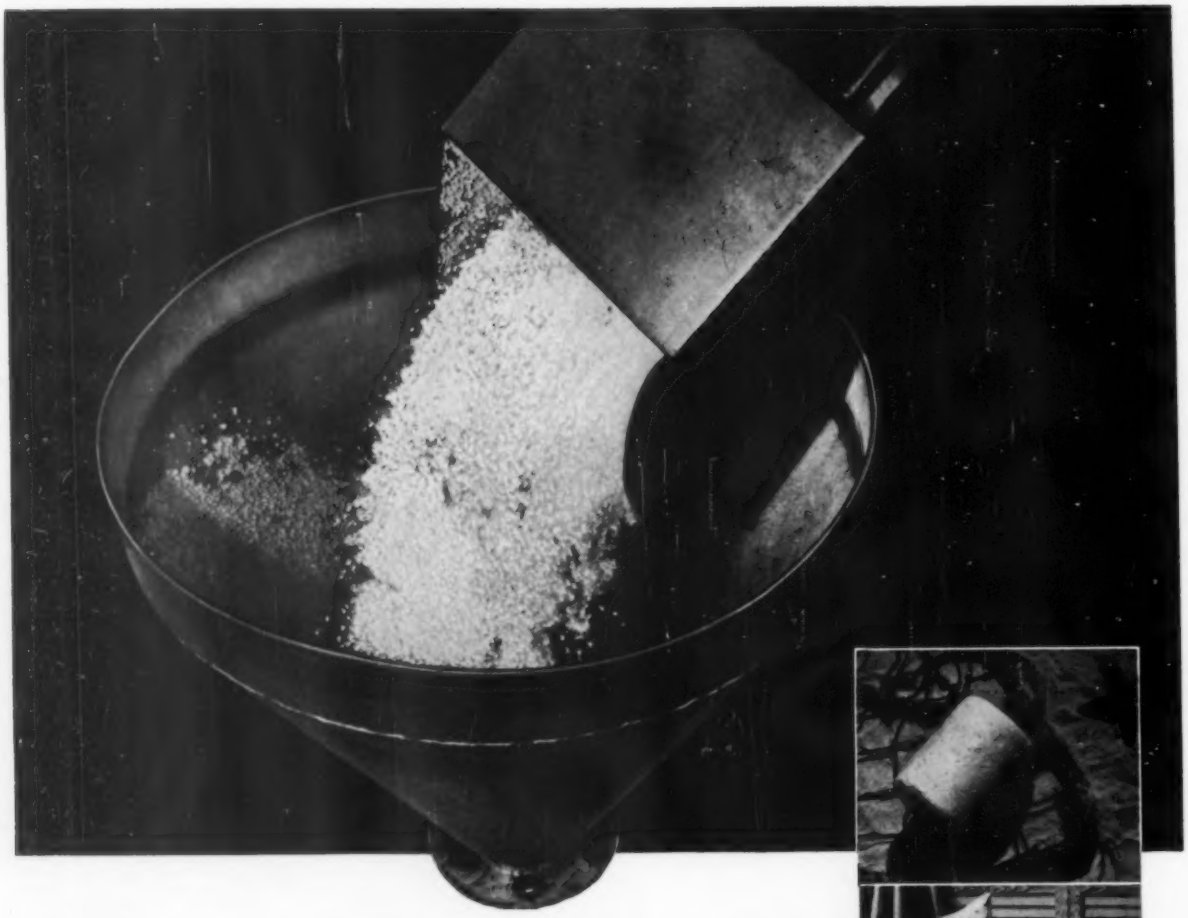
# YEAR

## DIVISION

**Pliovic—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio**

**CONSISTENTLY LOW FUSION** temperatures. High uniformity. Excellent viscosity characteristics. Good aging qualities. These are the properties that prompt a leading compounder to base his formulation for children's boots on PLIOVIC AO.

*Photo taken through the courtesy of Reynolds Chemical Products Company, Ann Arbor, Michigan.*



# Uni-Crest Expandable Polystyrene Beads

**Excellent for a wide variety of products and applications in packaging, low temperature insulation, panel construction, refrigeration, flotation, novelties and toys.**

United's Uni-Crest is ideally suited for products demanding high insulating efficiency, low moisture absorption and light weight. It is non-toxic, non-abrasive, non-dusting, shock resistant and has exceptional permanence and strength.

Uni-Crest beads are available in both regular and self-extinguishing types. Write for more specific information and a free sample.

The following information is furnished as a general guide to the properties of Uni-Crest, *using samples with densities of 1 and 1.25 lbs./cu./ft.*: Specific Gravity — 0.02; Compression Strength — 16-20 lbs./sq. in.; Energy Absorption (max.) — 29.66 in. lbs./cu. in.; Tensile Strength — 44.46 lbs./sq. in.; Bending Strength — 28.5 lbs./in. of width; Hydrogen-ion Concentration — neutral; Water Absorption — less than 2%; Water Vapor Transmission Rate — 7.9 grams/sq. meter/in./24 hrs. — 0.47 grains/sq. ft./in./1 hr.; Coefficient of Expansion — .00002676; Thermal Conductivity (K factor) BTU/hr./sq. ft./°F/in. — 0.23 at mean temperature of 40°F.

UNITED'S UNI-CREST

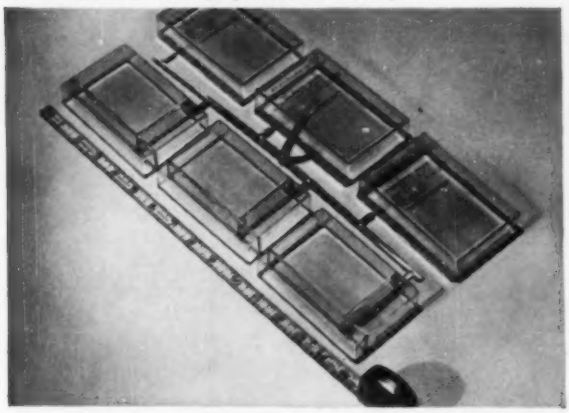
**DIVISION OF UNITED CORK COMPANIES**

*A Reliable Manufacturer of Expandable Polystyrene Beads*

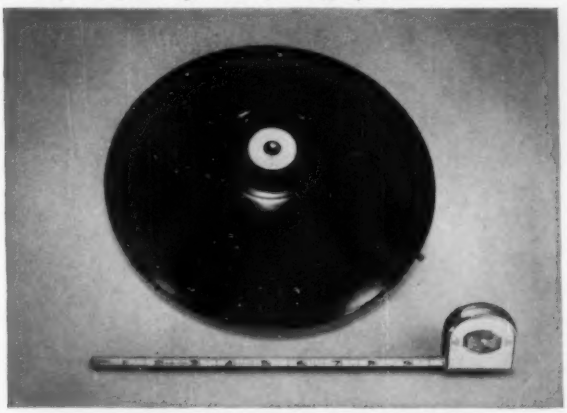
28 CENTRAL AVENUE • KEARNY, NEW JERSEY

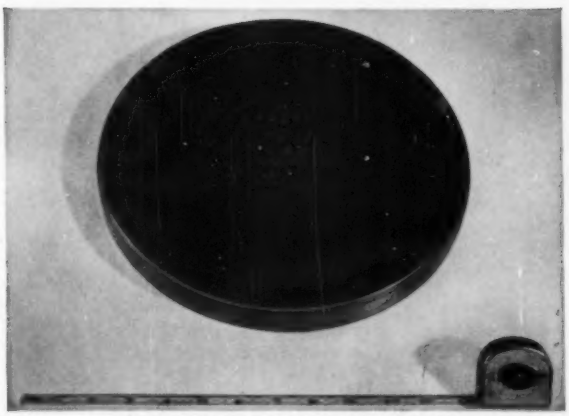
**Top molders depend on machine performance,** not promises. Here are 4 exceptional molding results produced on the 175T-4/6 oz. REED-PRENTICE injection molding machine. This is the kind of greater moldability cost conscious molders expect and get from the 175T. There's a full line of REED injection molding machines designed to handle today's needs, with the capacity to take tomorrow's requirements. Call your REED Sales Engineer today for details.

6-cavity box mold by North Star Industries, Minneapolis. Polystyrene shot weighs 6 oz. over a projected area of 90 sq. in.

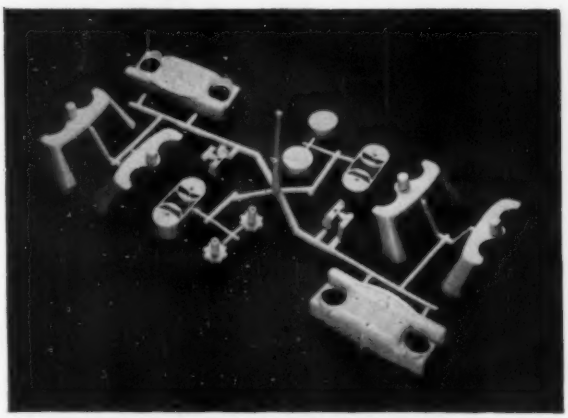


4-oz. Polystyrene Ice Bucket Lid is molded by Air Light Products, Omaha, Nebraska. Projected area is 78½ sq. in.





6-oz. Polyethylene Lid also molded by North Star Industries. Projected area of this 12" lid is 113 sq. in.



6.35-oz shot of rigid polyethylene produced by Trimold, Inc., on a 36-second cycle, molded for Fisher-Price Toys, Inc.

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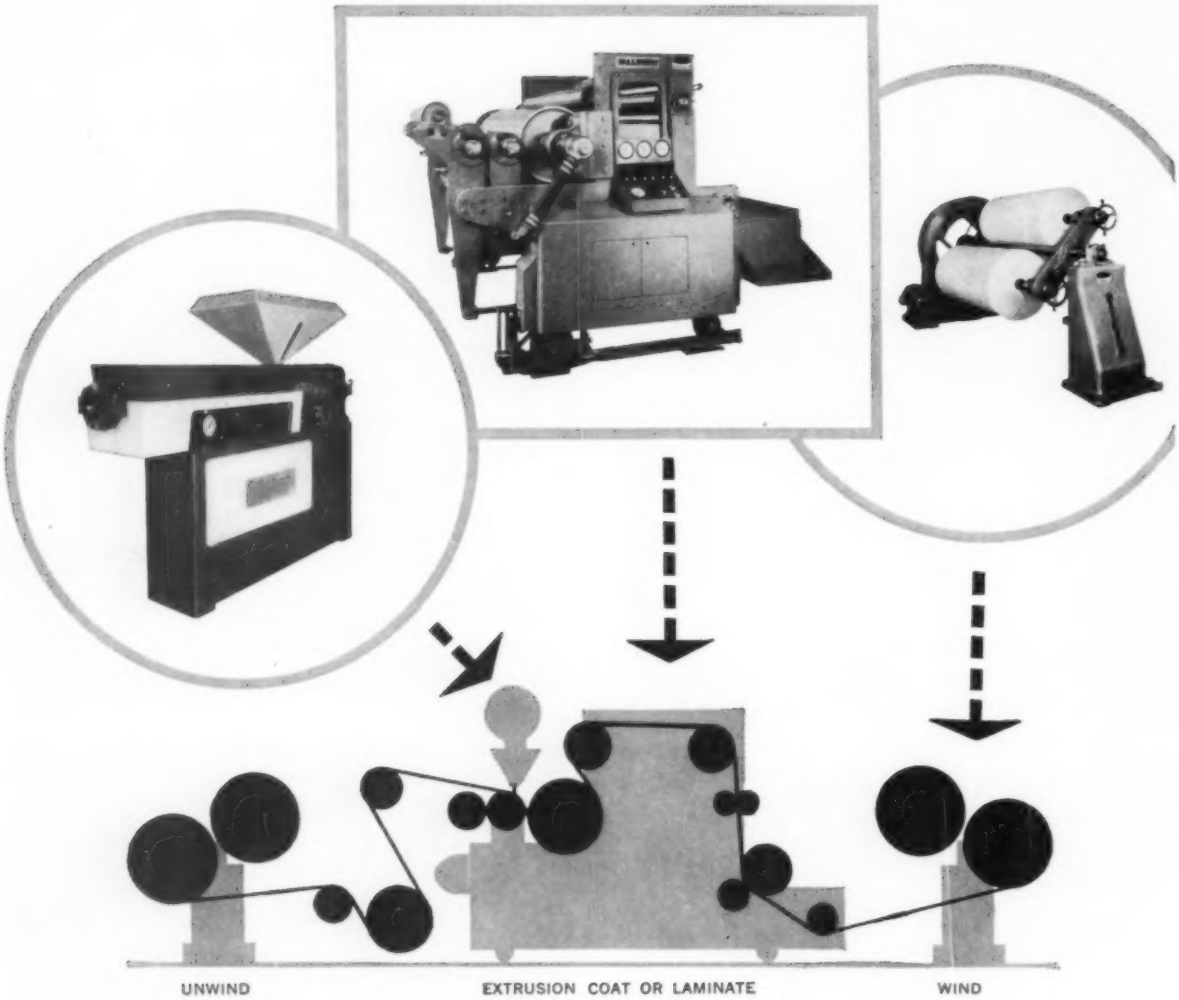


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# NEW MARKETS...
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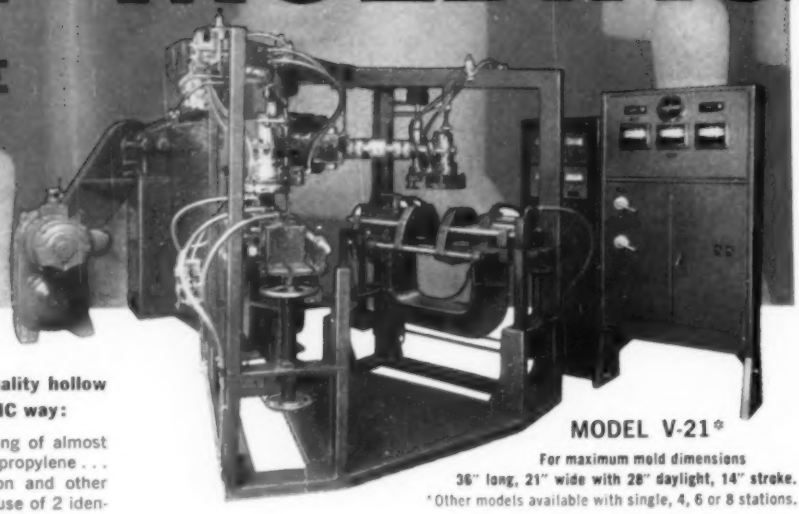
# MPM DIVERSAMATIC
# TWIN-STATION
# BLOW MOLDING
# MACHINE



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For maximum mold dimensions
36" long, 21" wide with 28" daylight, 14" stroke.
*Other models available with single, 4, 6 or 8 stations.

**Boost profits... blow mold high quality hollow products the low-cost DIVERSAMATIC way:**

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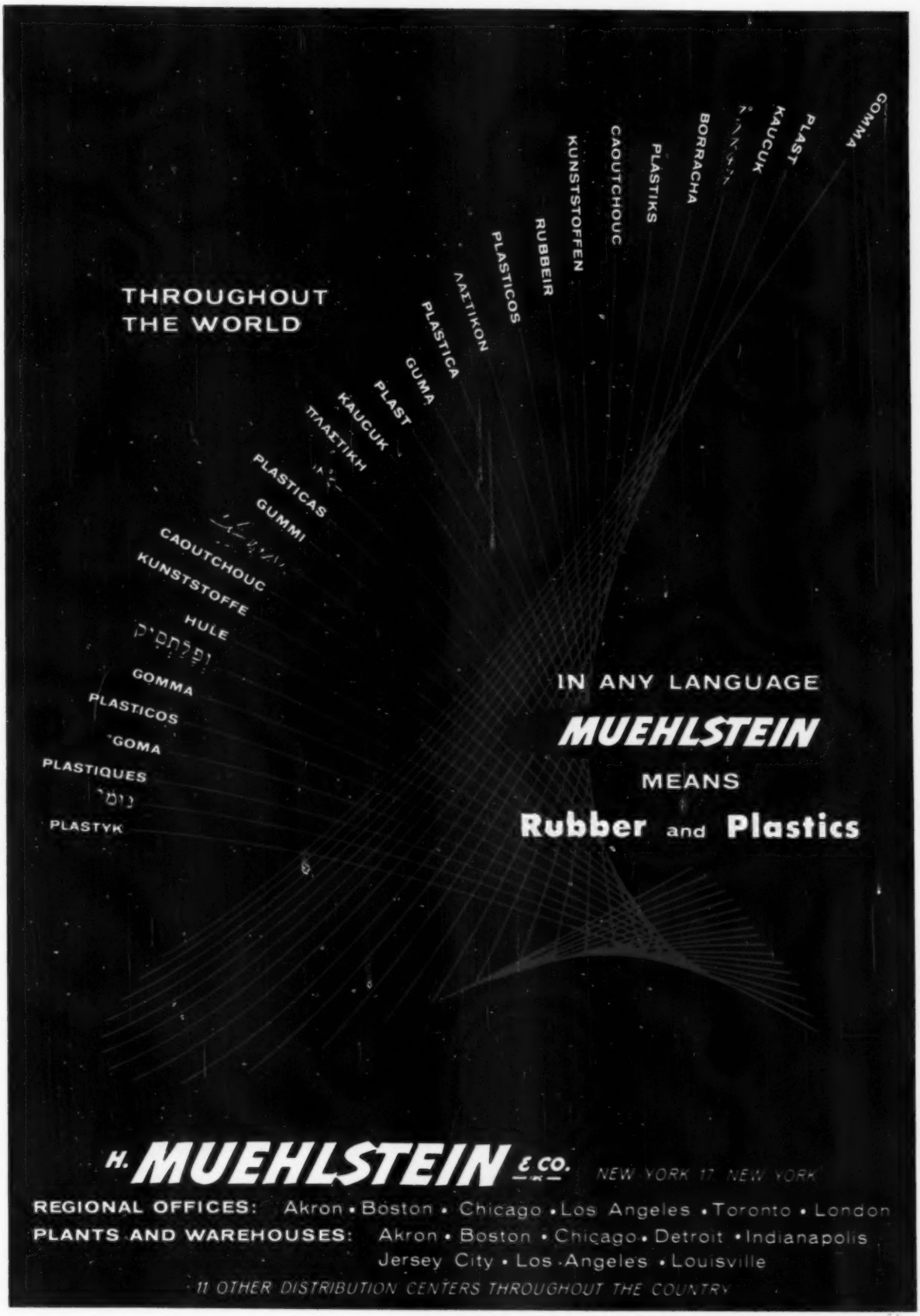
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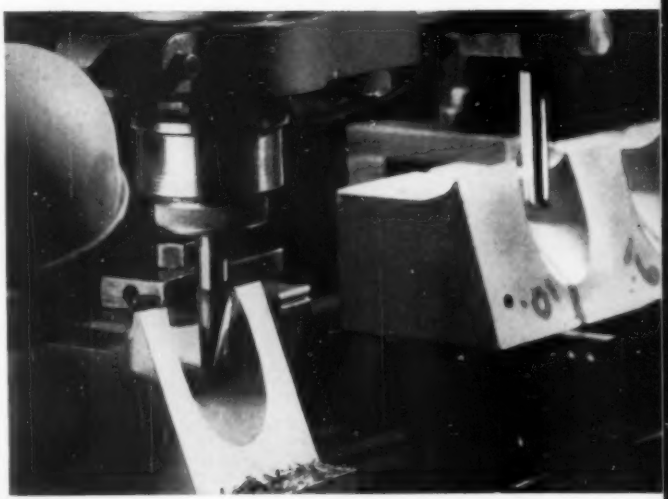
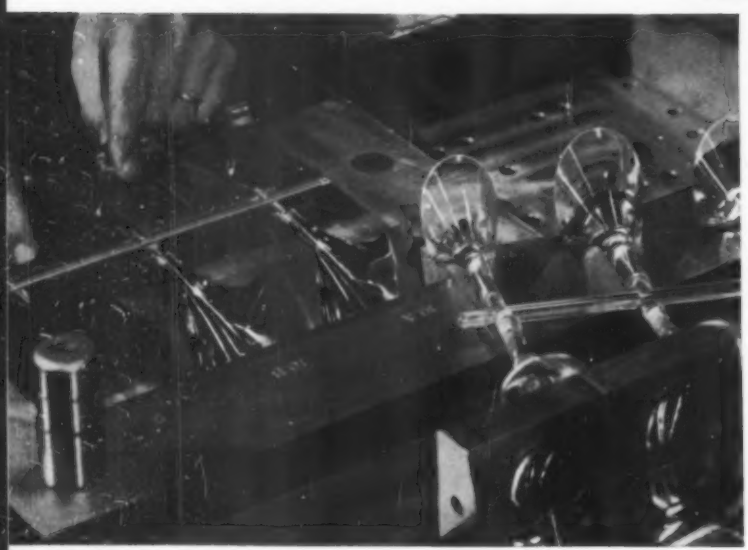
# Three good reasons why plastic molders keep using Lustre-Die Tool Steel

1. *High Polish.* It takes a beautiful polish, one that imparts a silky, smooth sheen to plastic products.

2. *Engineered for Molding.* Lustre-Die has a carefully balanced analysis, including alloy fortification, to provide just the right hardness for plastic-molding uses. It saves time because it's ready for use without heat-treatment.

3. *High Degree of Cleanliness.* Lustre-Die is carefully processed to assure a high degree of cleanliness to minimize porosity or surface pitting.





Your nearest Bethlehem tool steel distributor carries Lustre-Die in stock . . . in various sizes. Why don't you order a trial bar today?

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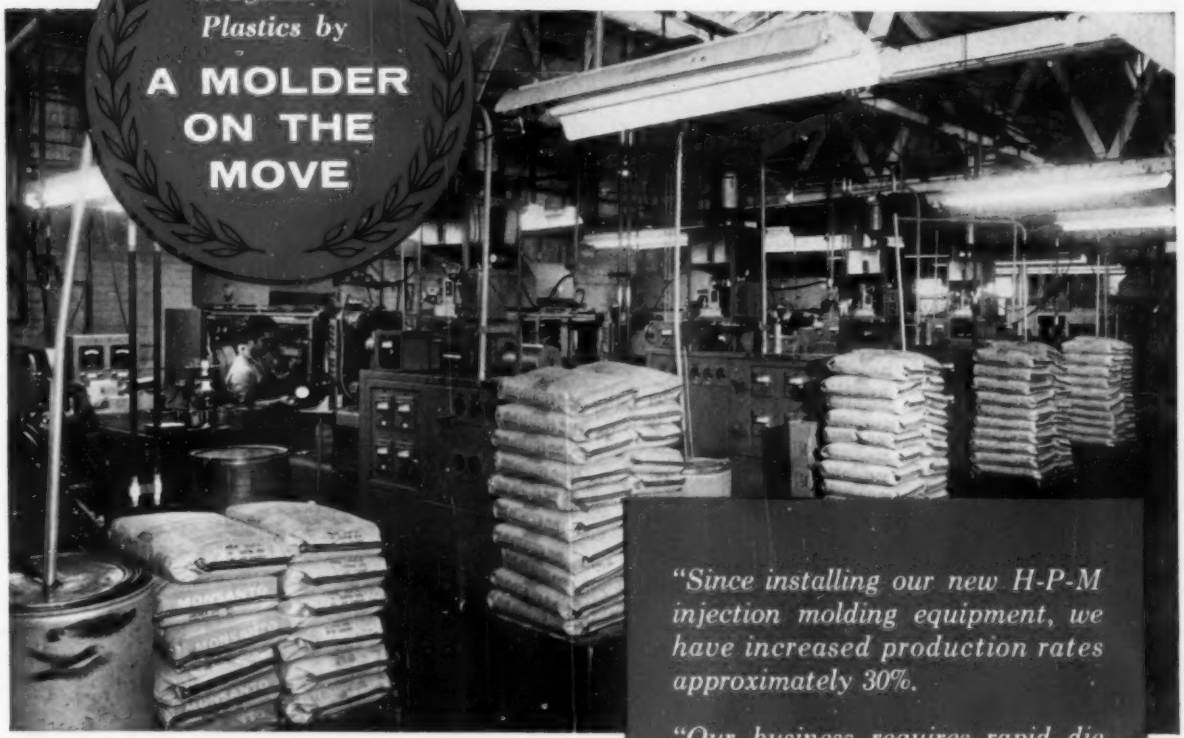
**BETHLEHEM STEEL**

*Progress in Plastics by*

# A MOLDER ON THE MOVE

Two 45 rpm records or one LP can be molded on these speedy six oz. H-P-Ms . . . 30% faster. (Popular music for molders!)



## H-P-Ms UP PRODUCTION 30%

This highly efficient plant is Etan Products, Division of Monarch Records, Los Angeles, California. How's this for a good looking shop? New production efficiency has been attained. Dual safety gates, hydraulically and electrically interlocked assure safety for the two operators on each machine. Mold changes are frequent. Simple machine adjustments speed mold changeover — save time — cut costs by keeping the machines operative. H-P-Ms have the features to make more profit from plastics in your shop, too. Call your H-P-M man today; use his experience to make your planning easier.

*"Since installing our new H-P-M injection molding equipment, we have increased production rates approximately 30%.*

*"Our business requires rapid die changeover and we find that the all-hydraulic clamp, with its fast adjustment feature, enables us to change mold set-ups with a minimum loss of production time.*

*"Not only do we regularly mold two 7" diameter records on our six oz. machines but we can easily mold one 12" record. Figuring that this is a total of 113 square inches of projected area, we feel that it is outstanding performance for the six ounce machine using a 200-ton hydraulic mold clamp."*

Dave Rothstein

Dave Rothstein,
Plant Superintendent

**THE HYDRAULIC PRESS MANUFACTURING COMPANY**
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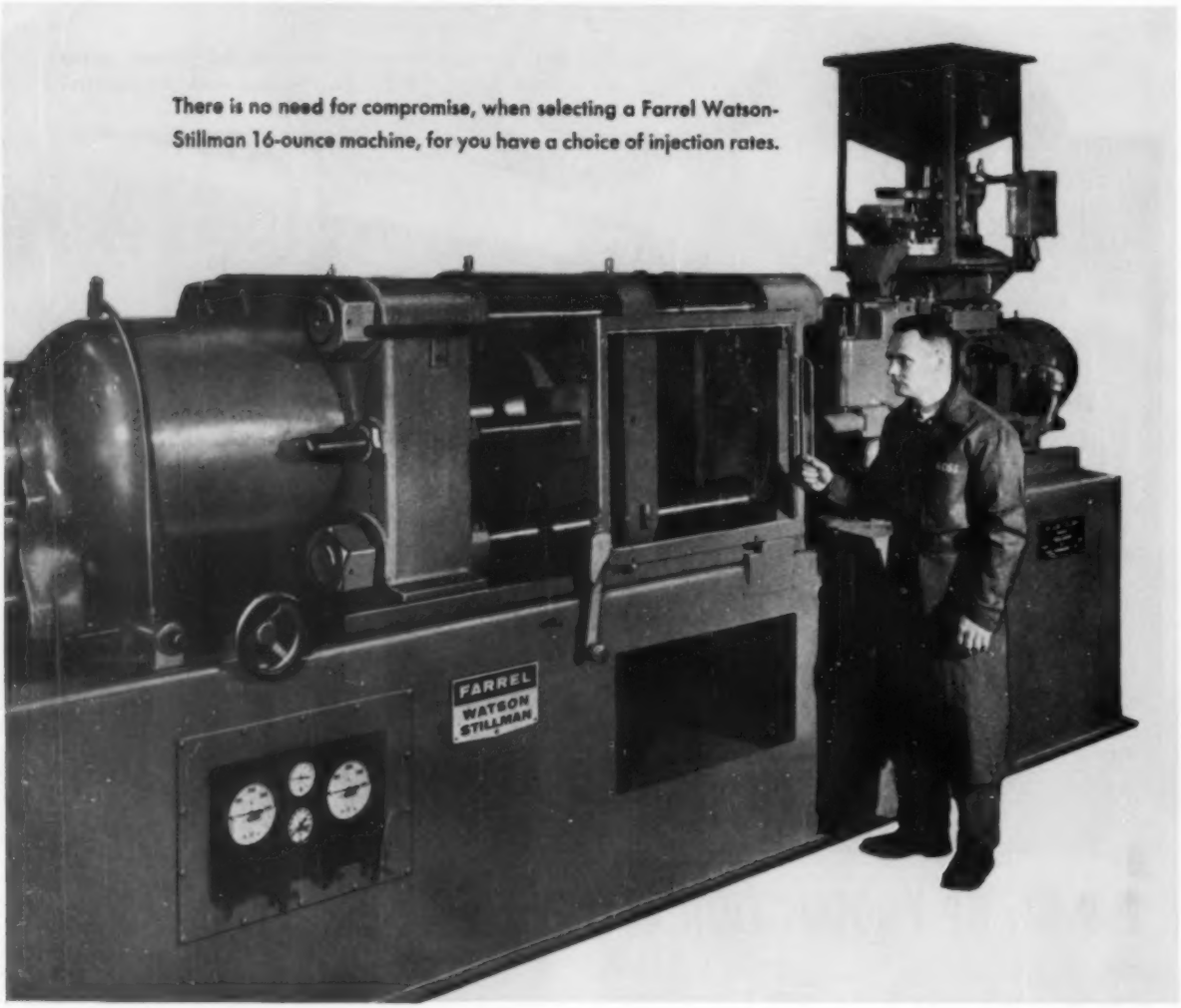
HPM

H8


There is no need for compromise, when selecting a Farrel Watson-Stillman 16-ounce machine, for you have a choice of injection rates.
FARREL
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# Here's a 16-ounce machine with a choice of injection rates

The Farrel Watson-Stillman 16-ounce injection molding machine is available in two models. Basically similar, these two designs differ in their clamping-ram and injection-ram speeds. The resultant injection rates of 1080 and 1620 cubic inches per minute permit a choice of machine ideally suited to the type of plastic to be molded.

Hydraulically operated, the machine has manual and automatic single-cycle controls. Both speed and pressure control of injection and clamping units are independently adjustable.

Complete details, including descriptions of the outstanding features of the machine, specifications for both models, illustrations and die-space drawing are included in bulletin 622-A. Write for your free copy today.

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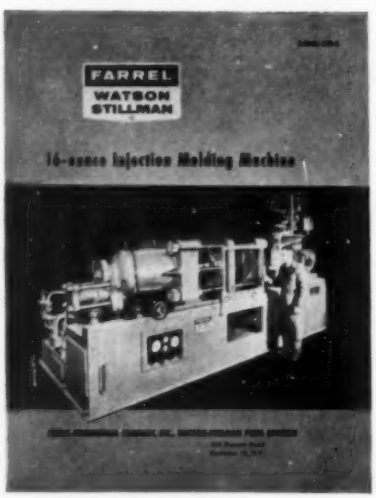

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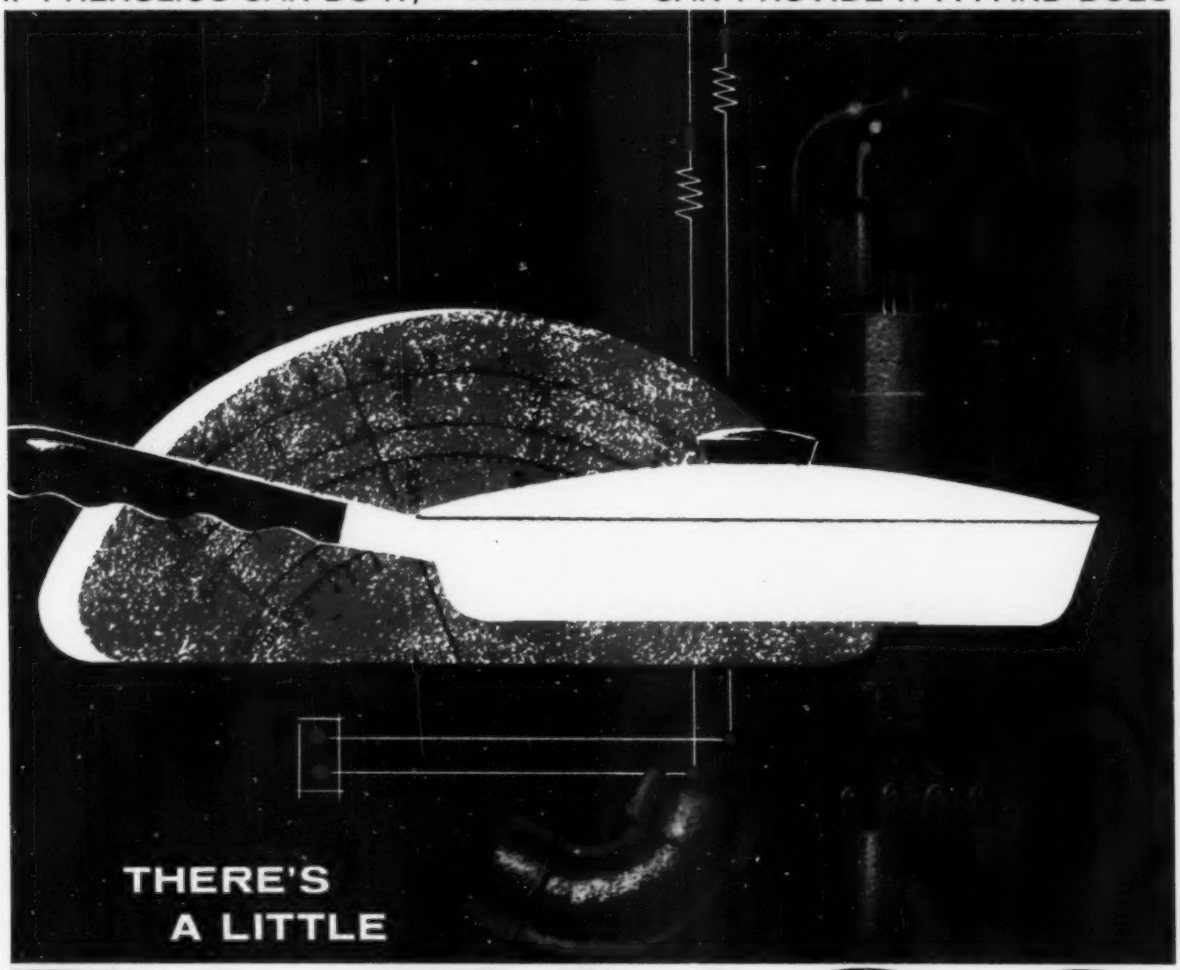


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You can be sure that, with many years of supplying critical and competitive industry, Plenco has or can *custom-formulate* just the molding compound you need: ready-made or specially-made; general purpose or very special purpose. Our selections are extensive, our facilities ample, our representative always available for consultation. Call on us at any time.

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Joe Foster, President,
offers customers Foster Grant's
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# "Let me tell you about the world's largest plastics laboratory," says Joe Foster.

That's what customers call our molding room — a **plastics 'laboratory.'**

I'd have to agree with them, too, because I know that we're the only company serving the plastics industry both as a manufacturer of polystyrene, impact polystyrene and Nylon 6 resins, **backed by 41 years of molding know-how.**

This means that as the world's largest manufacturer of sunglasses we use our own powder to mold with. And, believe me, since we introduced injection molding to America in 1931, we've met just about every molding problem in the book.

Our unique combination of raw material and end-product know-how makes it possible for us to help you with machine and mold design, tools and dies, color matching, marketing, styling, packaging and displays.

When you use Foster Grant resins, you draw on unrivaled plastics experience... experience that can help make **your** molding operation more efficient and more profitable.

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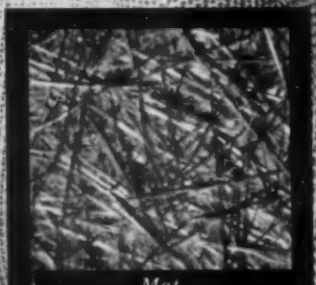
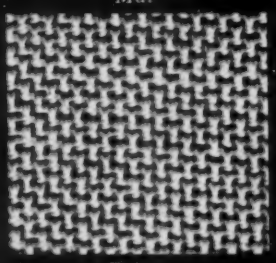
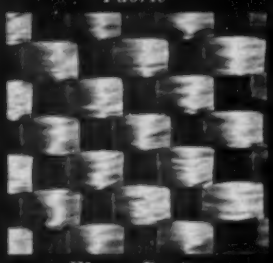


*Mat*

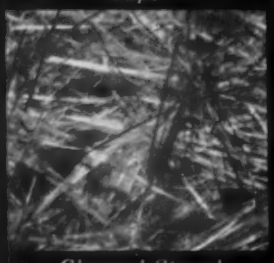


*Fabric*

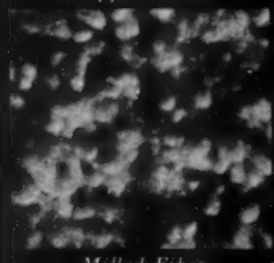


*Woven Roving*

*Tape*



*Chopped Strand*



*Milled Fiber*

## Great strength plus uniformity

Reinforce with a *fiber glass fabric* that allows you to design "strength where you need it" in your plastic products. UNIFAB gives you top strength per pound of reinforcement because of its controlled weave—weight uniformity—uniform thickness . . . checked and double checked to Ferro high-quality standards at every stage of production. *Every roll* you receive must conform to the highest "specs". Write for samples, specifications, prices.

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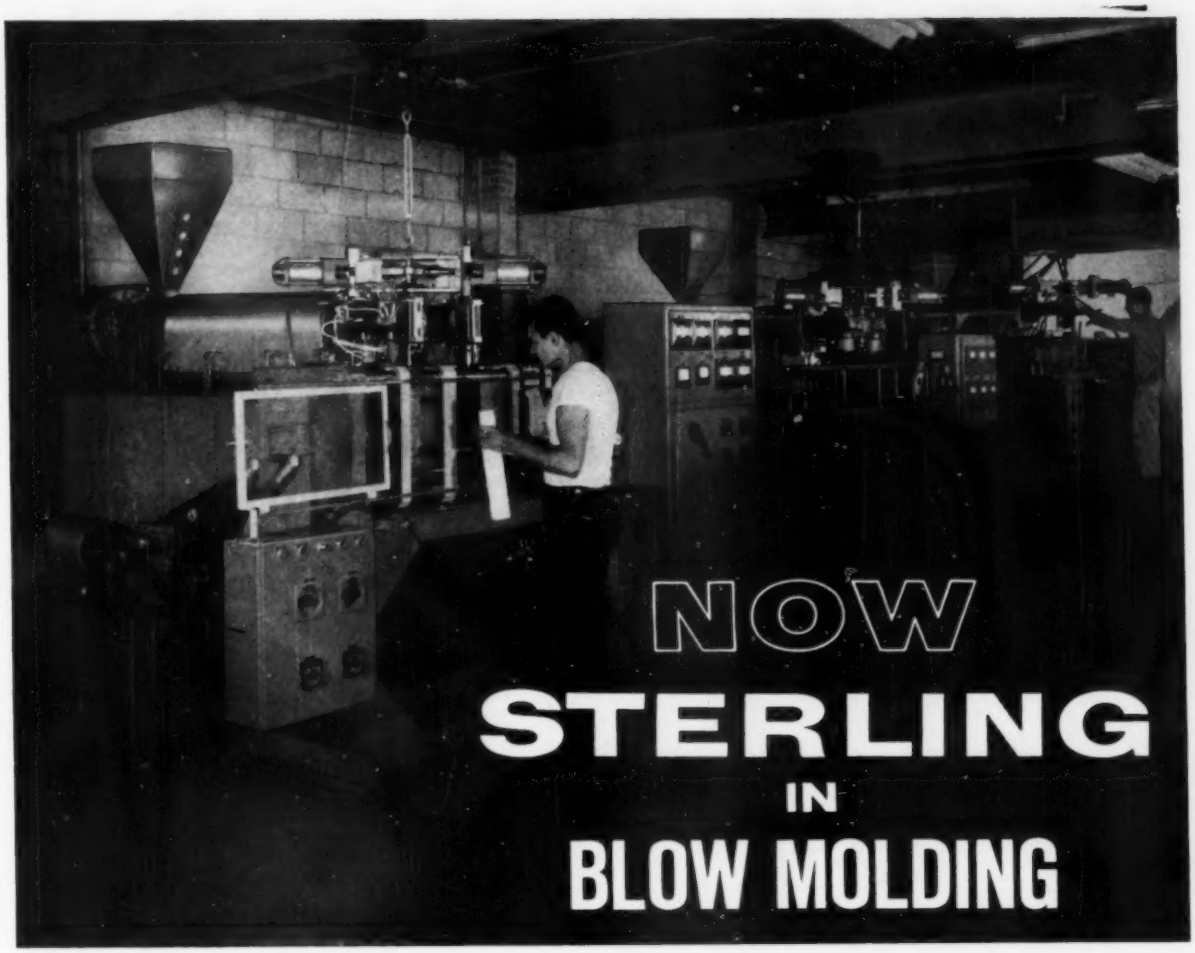


## used with
# AUTO-BLOW MACHINES

Here is an installation of Sterling Extruders working in conjunction with Auto-Blow blow molding equipment. Sterling figures importantly in installations where versatility, coupled with high production and quality is absolutely essential. Sterling Extruders have extensive application throughout the blow molding field, just as shown above—a typical operation using multiple Sterling units on a large production line. Their versatility is demonstrated in this process which requires flexibility, by meeting the demands of varying jobs and conditions. The Sterling Extruder provides superior performance and service, a product of long experience in the plastics industry. Sterlings are available in sizes 1½" through 8" with L/D ratios of 21:1, 24:1, or 30:1. Sterling offers a full range of variegated units and installations for both standardized and specialized requirements. For full details, write to—

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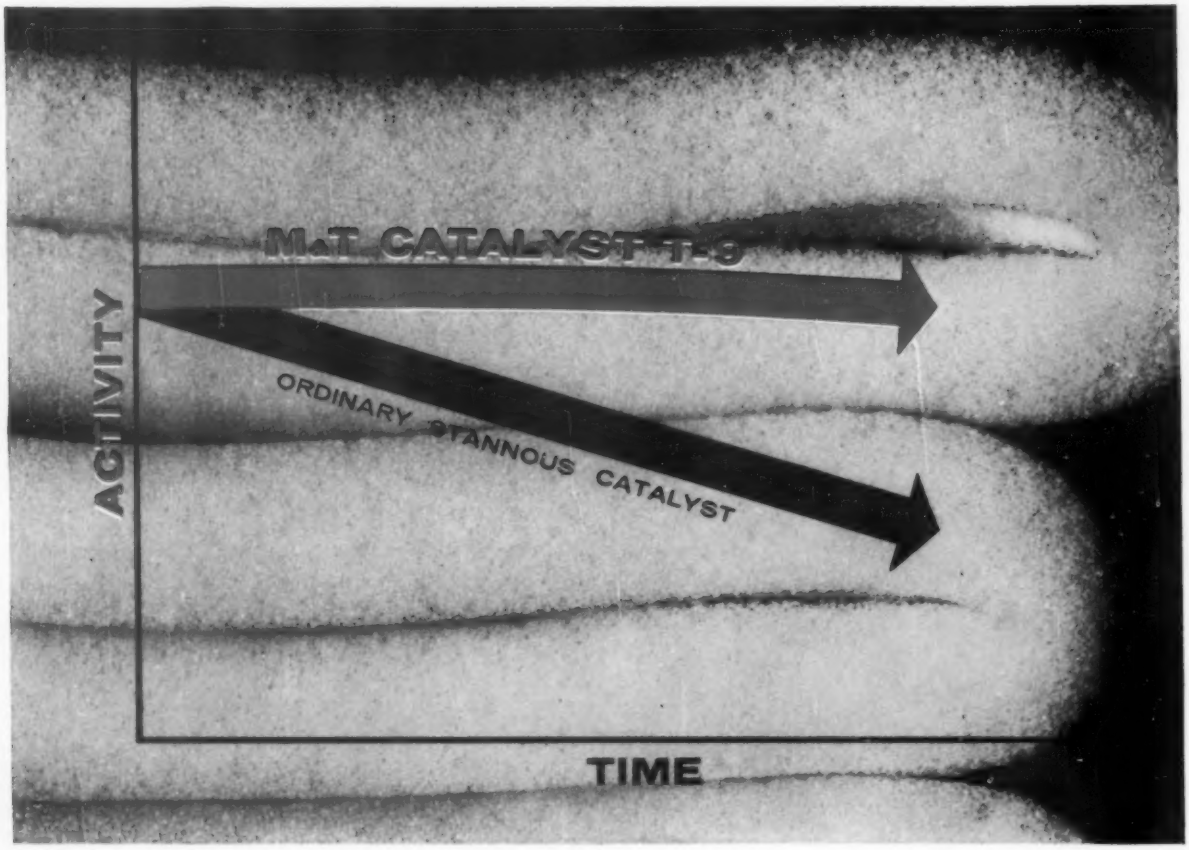
# This U-Foam Catalyst doesn't die!

## Instead, it gives you dependable, live activity for superior "one-shot" foams




HERE IS a new and powerful catalyst with remarkable retention of catalyst activity. Produced by a new process, M&T Catalyst T-9 offers more economical performance by providing superior, more predictable results than the stannous catalysts in common use. For this reason M&T Catalyst T-9 is replacing ordinary stannous octoate, for example, in many "one shot" urethane foam systems. Try it!

Data sheets, sample and prompt commercial shipments are available. Write to METAL & THERMIT CORPORATION, Rahway, N. J.

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**Foam Catalysts:**
M&T Catalyst T-9 (stannous type)
M&T Catalyst T-12 (organotin type)
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**Flame Retarders:**
THERMOGUARD* H—Hi tinctorial strength antimony oxide
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**Stabilizers:**
THERMOLITE® Organotin Vinyl Stabilizers
THERMOLITE® Ba-Cd and Auxiliary Stabilizers *TM

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METAL & THERMIT Corporation, Rahway, N. J.
Sn Sb P Si Ti Zr | organometallics and inorganics

# NOSCO "CAN DO"

*Molds Yesteryear's Traditions to Today's Modern Living . . .*

## Automatic Packaging is Bonus of "Can Do" Service . . .

Time honored products are a favorite victim of changes in tastes and living habits. Wyeth Laboratories learned that about their traditional transparent blue glass eye cup. That's why they turned to Nosco "Can Do."

The glass eye cup was an almost priceless symbol—backed by years of advertising and consumer acceptance. But it needed styling refinements to achieve a more modern cosmetic look. And could it be more durable to withstand the abuse of smaller, overcrowded medicine cabinets and possible falls on harder floors?

Nosco said "Can Do." The new molded plastic cup preserves identity by being an exact color match and retaining the basic lines. But Nosco's engineering know-how refined the style to give a more delicate appearance while actually increasing shock resistance. And unit price was held down by Nosco volume production—20,000 eye cups in a single 24-hour day.

But that wasn't all. Nosco "Can Do" means more than just engineering and production skills. It means *complete* service, *complete* facilities. Wyeth gains an added plus from this. Nosco automatically packages each eye cup in an individual plastic bag immediately after molding, thereby preserving its sterile qualities.

Does new competition have an advantage over *your* time honored product or package? Nosco can retain your traditions, while giving you the benefits of modern, lightweight plastics. For quality-controlled plastic products—either injection or blow-molded—contact the competent Nosco representative near you.

**NOSCO plastics, inc. · erie 5, pa.** *One of the world's great injection molders.*

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They're the men on Witco's technical service staff. And, if you have ever called upon them, you know that Witco offers truly customer-oriented service. Our highly-trained technical men are on the road and in customers' plants as often as our salesmen. With them, they bring a willingness to work for *you* and a knowledge of Witco's products and how best to use them to help solve problems...improve products or processes.

Up-to-date scientific equipment, like this gas chromatography instrument, at Ultra Chemical's Paterson laboratory, is extremely useful in ferreting out the causes of customers' processing problems, and contributing to their solution.

Carbon black compounded in rubber is tested to assist Witco-Continental customers . . . in meeting their product specifications... in improving rubber products with specific types and grades of blacks.

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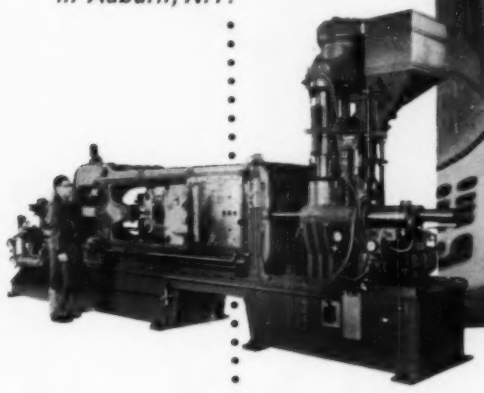
# "These Quality Parts run best on our new 24/32 ounce LESTER...

## NO WELDS...
## NO FLASH...
## ...just perfect finish!"

*So says Mr. L. A. Lynch (right), superintendent at Auburn Plastics, Inc., in Auburn, N.Y.*



"For example, we had been running this Remington adding machine cover on another machine, with considerable trouble over a weld mark on the front wall of the part. We worked hard to correct this, modifying the mold, trying various materials, and finally raising mold and material temperatures and lengthening the cycle."

Mr. E. F. Baran (left), general foreman, continues. "Then we put it on the new 24/32 ounce Lester. It took off! Lower temperatures, no weld or flash, and just the right finish to please our customer... not to mention a distinct improvement in the cycle.

We really don't know the maximum plasticizing capacity of this new Lester...we haven't hit bottom yet. And we're particularly pleased with its sensible range of controls in cycling speed, mold stroke adjustment and heat control."

*Complete 4-page spec sheets on the new long-stroke L-450-24/32 ounce Lester are available on request.*

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Makers of *quality* vinyls now have added assurance equivalent to a second source of low-temperature and polymeric plasticizers as Emery will soon activate its new 6-million dollar ozone-oxidation and esterification plant. The new plant will increase several-fold the supply of azelaic and pelargonic acids and their esters. It is these two unique acids that give Plastolein Plasticizers their superior properties—properties that give vinyls lasting performance, warm feel, and the look-appeal required by makers of quality products. For more details on Plastolein 9058 DOZ, the best low temperature plasticizer available, and Plastolein 9720 Polymeric, the lowest priced, most versatile polymeric, write for our brand new 28-page Emeryfacts titled "Plastolein Plasticizers."

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**Especially for injection molding up to 1½ ounces involving inserts or loose cores**

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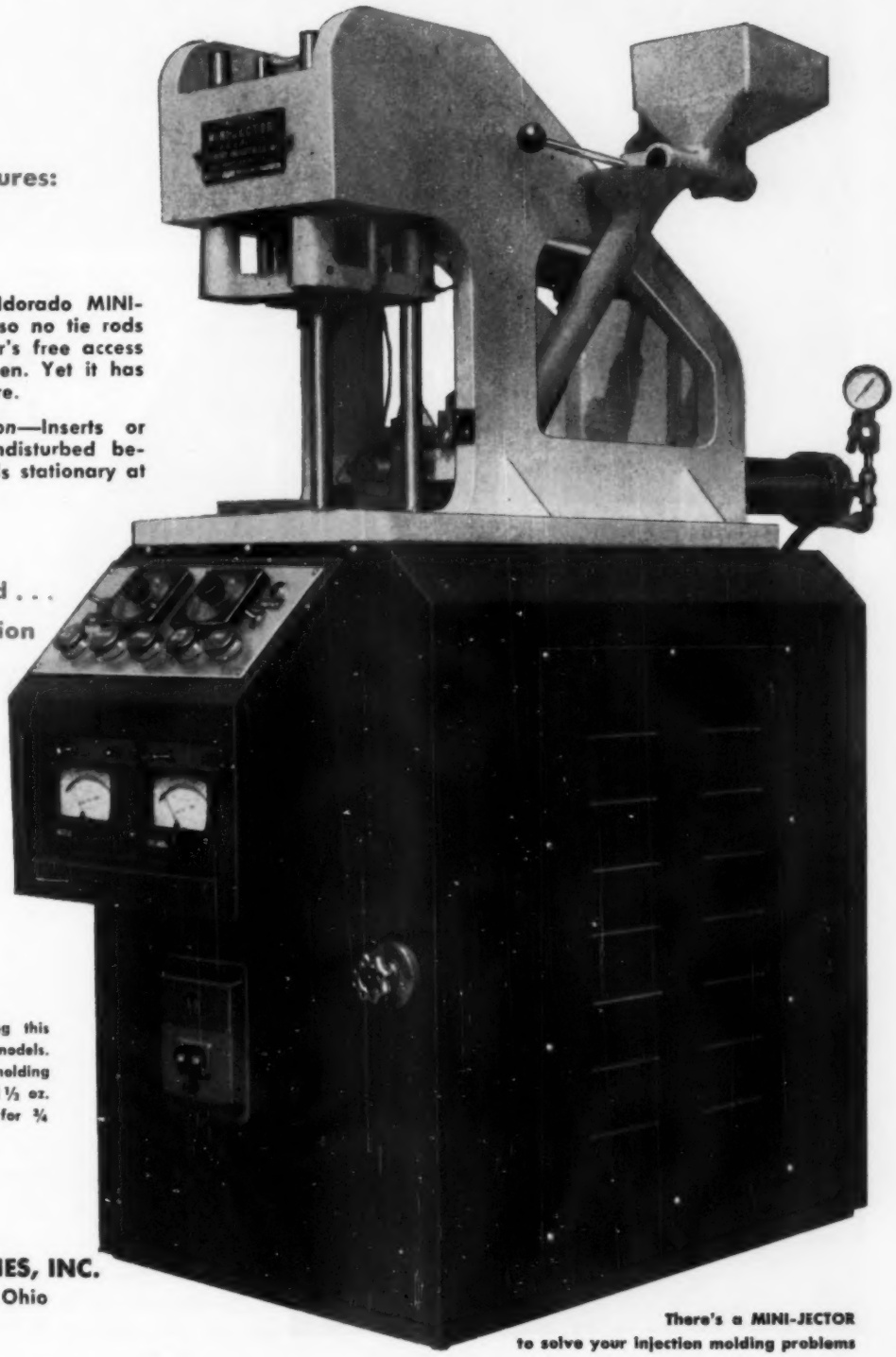

**Outstanding Features:**

***No Tie Rods in Way***—Eldorado MINI-JECTOR is engineered so no tie rods in front hinder operator's free access to mold when it is open. Yet it has ample clamping pressure.

***Vertical Clamp Operation***—Inserts or loose cores remain undisturbed because bottom of mold is stationary at all times.

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in volume production

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FREE 56-page catalog describing this and all other MINI-JECTOR models. MINI-JECTORS solve injection molding problems from sub-miniature to 1½ oz. Prices start from under $1,000 for ¾ oz. model.

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Box 71, Newbury, Ohio

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of equipment for

INJECTION MOLDING

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**Blow Molding Machines** with piston and screw feed up to 215 pts

**Automatic Serial Presses** for screw caps etc.

**Compression and Transfer Molding Machines** up to 300 tons capacity

**Extruders and complete Automatic Plants** (with screw diameters 1¼" 1¾" 2½" 3½" and 6" approx)

## INJECTION MOLDING MACHINES

**from 1/10 oz. upwards**

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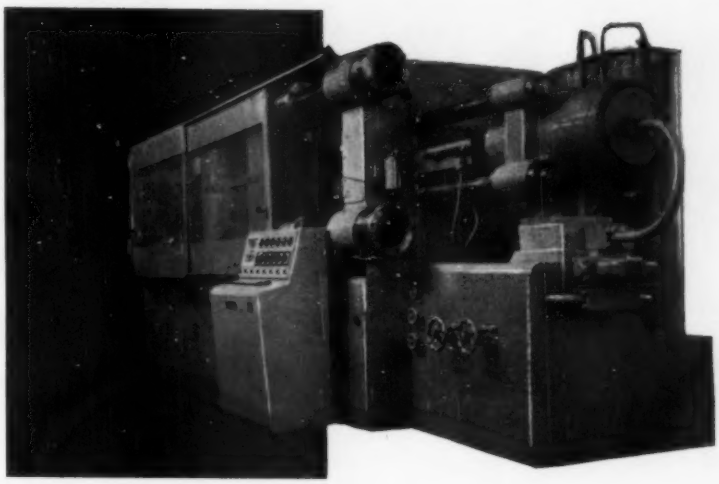
SCREW PLASTICIZING UNIT
from 1 – 350 OZS



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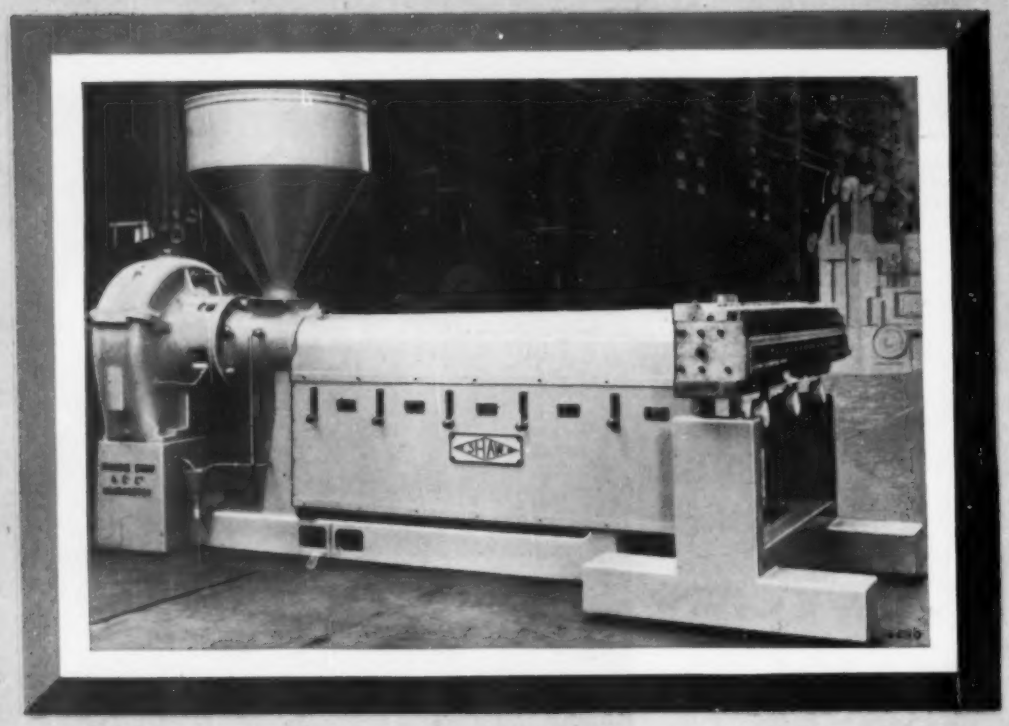
# behind every **Francis Shaw** machine

## research – design – quality engineering



The new Francis Shaw P.4½" extruder for high impact polystyrene sheeting represents a completely modern approach embodying all the latest techniques

Constant research and development, close co-operation with users, advanced design, selected high quality materials . . . These, coupled with long experience, help to create processing machinery of unrivalled performance.

* Designed for easy maintenance and long life
* Direct heating of cylinder and diehead through separate zones
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OVERSEAS AGENTS THROUGHOUT THE WORLD

P4358

**THERMOFORMING** . . . Pull-down of vacuum form occurs at about 375°F. Operator is shown stamping serial number on cover half during cooling cycle.

**FINISHING** . . . After trimming, rubber shock strips are applied with epoxy adhesive. Flame treating oxidizes and prepares desired surfaces for adhesive.

**ASSEMBLING** . . . Hardware is mounted and finished cover inspected. Notice circular base with perforated desiccant container.

**PACKING** . . . at Aerojet-General, thrust chambers are protected for shipment. Protective covers remain on until firing.

# Rocket Engine Covers Thermoformed from MARLEX* Sheet

This unique packaging item, made by Thermo-Plastic Products Company of San Carlos, California, protects the first- and second-stage thrust chambers of the Titan missile during missile assembly and shipment . . . right up to actual firing. Initially, these covers were glass fiber laminate. Now, using MARLEX 6002 High Density Polyethylene, Thermo-Plastic does the job at considerably less than the previous cost—providing lightweight covers with high impact strength . . . free from warpage and cracking . . . and chemically resistant to fuels, lubricating oils, greases, solvents, alkalies, detergents, and most acids.

This rocket engine cover is a good example of what can be done as a result of the superior thermoforming characteristics of sheet made of MARLEX. Here, Thermo-Plastic draws to a maximum depth of 22 inches the 54″ x 48″, 230-mil sheet supplied by Kal Western Plastics, Inc., Pico Rivera, California. Cover halves and circular bases are separately formed, yet mate perfectly when assembled to provide a gasket seal against moisture.

If you are interested in heavy-duty, large or small shipping containers . . . or such items as tote boxes, refrigeration liners, dome covers, trays, any item involving the structural forming of sheet—MARLEX can be your answer for improved quality at less cost. Thick and rigid, thin and flexible, large or small, the superior physical characteristics of MARLEX sheet permit precision thermoforming to accurate dimensional tolerances. Moreover, there are many MARLEX resins to choose from—providing a wide range of material properties.

For complete details on thermoforming and a list of MARLEX sheet suppliers near you . . . contact one of the offices listed below.

*MARLEX is a trademark for Phillips family of olefin polymers.

**PHILLIPS CHEMICAL COMPANY, Bartlesville, Oklahoma,** a subsidiary of Phillips Petroleum Company

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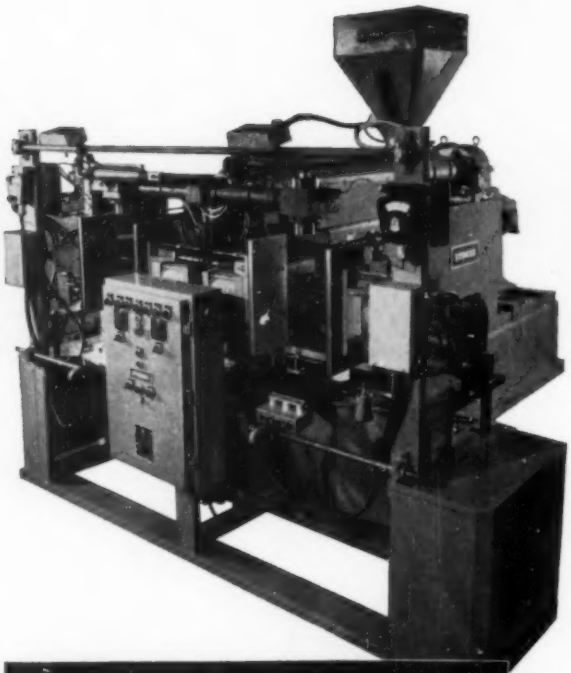
PHILLIPS 66 MARLEX

# Why the new Stokes blow molder puts more profit into hollow plastics production



**• proved technique**
**• new simplified design**
**• complete unit**

Stokes *completely* packaged dual-manifold blow molder brings you higher speed with flexible operation and wider versatility—at lower cost—than other units. And it's all due to this basic reason: Stokes engineers—drawing from a vast background in plastics—delivered a clean, modern, simplified design that can be used with any number of blowing methods. The new unit lowers operating and maintenance costs far below those ever before attained. Net result: higher profit margins over a wide range of products.

## Convince yourself. Do you get these plus features in any other blow molder?

**Full range of product sizes on a single machine**—unique clamp eliminates tie bar and sliding rails in the mold area, providing a completely unobstructed flow path that makes it possible to form long, deep products. Larger open area simplifies automatic or semi-automatic removal of molded items.

**High capacity and operating flexibility**—you get more productive capacity than with single clamp machines, and greater flexibility than moving mold types. Dual manifold construction lets you operate one or both mold stations with either continuous or interrupted extrusion.

**Completely integrated standard unit**—you get a complete package including all controls, instruments, valves and operating accessories. If you already have extruding equipment, the press and manifold sections can be supplied separately.

**Unusual flexibility**—you can take full advantage of the blowing method best suited to your product without loss of production rate. Information regarding licenses for blowing by any of a number of methods is available.

A new four-page brochure gives you all the facts on the new blow molder. We'd like to send it to you. We're sure it will mark the beginning of a more profitable blow molding operation for you . . . write for it today.

*Packaging Equipment Division*
F. J. STOKES CORPORATION
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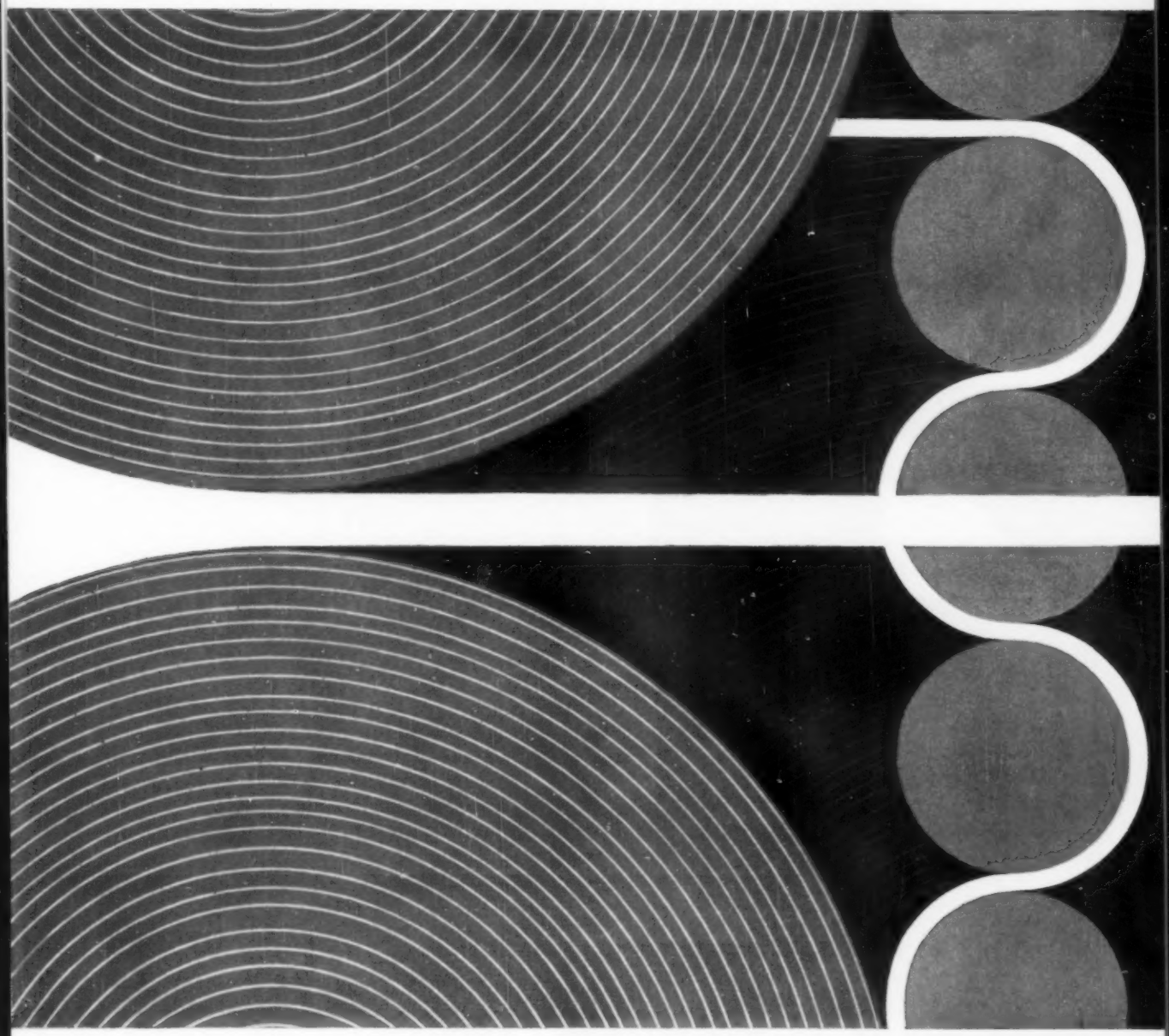
**STOKES**

# This is what really counts



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# Shell Chemical is your new source for

# Poly-styrene

SHELL CHEMICAL now offers you a broad line of polystyrene molding compounds suitable for most polystyrene applications . . . both general purpose or high-impact. Clear, natural, and colored materials are available in appropriate granulation and lubrication levels.

You can be sure of a uniform product backed by Shell's long experience as a dependable supplier of chemical raw materials to the plastics industry. Prompt delivery of large or small quantities will be made from conveniently located warehouses. Shell Chemical has technically trained men available to assist you with your molding, extrusion, and vacuum forming problems.

Find out what this new source of supply can mean to you by getting in touch with your nearest Shell Chemical district office. Your letterhead request will bring additional information.

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# THE PLASTISCOPE*

News and interpretations of the news — By R. L. Van Boskirk

**Section 1** — **July 1960**

**Is polyethylene slowing down?** The answer for the first four months of this year at least was "yes." Needless to say, there are a lot of ifs, ands, buts, whereases, and howevers involved. It is still a thriving and growing commodity, but the rate of growth for conventional PE shows signs of leveling off—although linear (high density) PE is showing modest growth. Perhaps the present situation is simply a lull before another outburst—a Mickey Mantle who has cooled off but will come strong again.

Total PE consumption, both conventional and linear, for the first four months of 1960 was around 380 million pounds. This is about the same as the last four months of 1959, but is some 30 million lb. above the first four months in 1959. The May through August four-month period in 1959 was around 365 million lb., and it is not expected that the same period in 1960 will show a sensational increase over that period. But a modest improvement is possible. Scarcely anyone now expects polyethylene to make another huge 280-million-lb. increase in 1960. Most estimators will settle for a 150-million-lb. increase—some of them for much less.

Total consumption of conventional PE during the first four months of 1960 was approximately 330 million lb., compared with about the same in the last four months of 1959. This is not a serious situation, but it is the first four-month period without a gain in a long time and has created much tongue-wagging.

**Linear polyethylene moves in.** The growth of linear, or low-pressure, PE since about one year ago has added considerable volume to total polyethylene consumption figures. In the first five months of 1959, consumption was at from 4 to 5.5 million lb. a month. In June of that year it went to over 7, and climbed to about 13 million in November. March and April of 1960 were also in the 13-million-lb. class. The first four months of 1960 saw almost 50 million lb. consumed, compared with 45 million in the last four of 1959.

Total amount of linear polyethylene consumed in 1958 was 56 million lb. according to Tariff Commission reports. The 1959 estimate is around 90 million. It is possible that 1960 may see 170 million lb. consumed, depending upon the extent to which detergent bottles can be produced.

**Will price remain at present level?** The recent slow-down in conventional PE sales growth plus an ever-increasing production capacity has naturally resulted in much gossip concerning price structure. The current price of 32½¢, minus ½ to 1¢/lb. for quantity lots of G-P polyethylene, is less than firm.

Processors claim that they are being offered so-called "off-grade" material at prices well down in the 20-to-30¢ range. Much of this could come from compounders, but the age-old practice of selling first-grade material at an off-grade price is also claimed to be at work. This is nothing (To page 43)

*Reg. U. S. Pat Off.

# CAMPCO

**Plastic Sheet and Film**

*some practical IDEAS for its use in PACKAGING*

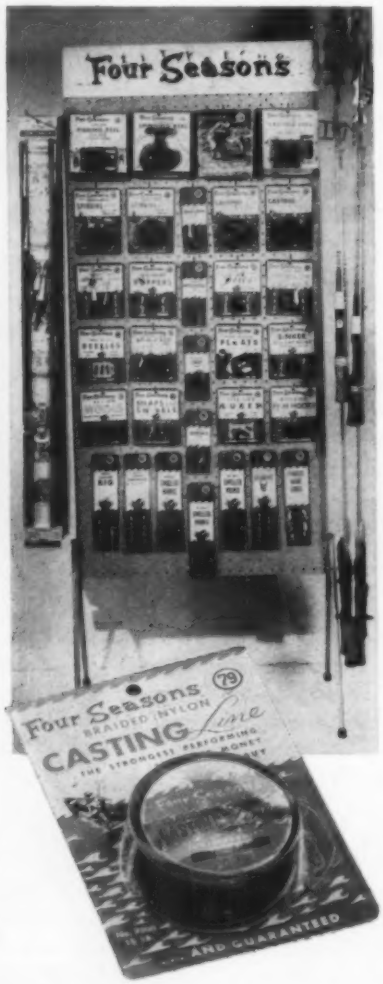
## Design with CAMPCO

## Leonard Seeley, designer for Plastofilm, Inc., tells how Campco Butyrate lures fishermen for Four Seasons

Packaging a line of products containing more than forty items can be a problem, particularly when they vary all the way from fish hooks to rods and reels. The situation called for packaging that would be protective and would, at the same time, provide maximum display. And a distinct "family" resemblance had to be maintained throughout the group.

"The entire idea was developed in close cooperation with the principals of Four Seasons, Inc.," said Mr. Seeley. "The rack itself was designed for use in stores having heavy traffic but not having a fishing accessories department. Consequently, it had to be a display that would attract, stop and sell the passerby."

The forty packaged items, which encompass the total needs of the fresh water fisherman, are bubble-packaged in transparent Campco B-120 cellulose acetate butyrate. According to Mr. Seeley, "Examination of various display techniques practical for this varied merchandise showed bubble packaging to be the most versatile, offering worthwhile economy together with fine quality. Furthermore, this one material, Campco B-120 Butyrate, was found admirably suited to all the packages regardless of their size or shape. This, again, resulted in important production economies."



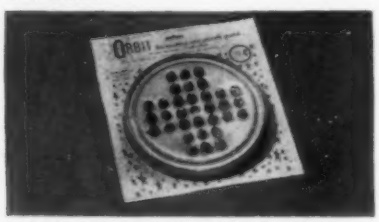

Heat sealed to printed cards, the bubbles add such sparkle and lustre to the merchandise that a recent jury of variety store industries awarded the Four Seasons display their Silver Award for outstanding packaging.

Plastofilm, Inc. designed, developed and manufactured these butyrate bubbles which have contributed so much toward the remarkable success of the Four Seasons display rack.

## Campco sheet is used for both the toy and the package

Toy packaging, more often than not, means blister packaging. But there are exceptions like this handsome new puzzle game, "ORBIT", manufactured by Amos-Burke Plastics, Inc., of Syracuse, New York.

The base of the game is made of Campco extra high impact styrene, vacuum formed on a male mold. This tough, rugged material was selected for its ability to withstand the wear and tear of rough handling, as well as for its smooth, attractive finish so pleasant to the touch.




When the game is on display, it seems at first glance, that the marbles are almost popping out at the young buyer. The illusion is maintained by the clear sheet of Campco butyrate which is so closely formed over the marbles and the base as to be practically invisible, yet adding a sparkle and brilliance that is most attractive. This, of course, holds the marbles tightly in place and affords complete protection for the game whether on display or in storage. The complete package includes a die-cut card together with complete instructions for playing the game.

**Your CAMPCO representative** has some interesting and worthwhile information on the use of plastic sheet and film.

**SEE HIM SOON**

For the name and address of the one nearest you, see Thomas Register or Conover-Mast Purchasing Directory.

**Received Your Campco Personal File?** This data-packed reference file on thermo-plastic sheet and film is yours on request—just send name and address on your company letterhead to Campco, 2717-H Normandy Avenue, Chicago 35, Illinois.

**CAMPCO** Sheet and Film, **a Division of Chicago Molded Products Corp.**

# THE PLASTISCOPE

(*Continued from page 41*)

new in marketing practice, but it is a warning that some of the major producers are going to get mad (angry, that is) and one of them may start the ball rolling with a major slash in list prices. If and when this happens, the base price of first-grade conventional polyethylene is likely to drop below 30¢—a target that was pointed out by one of the major producers some years ago. The answer may depend upon whether or not sales volume begins to increase at a considerable rate.

**Linear polyethylene price structure.** The base price for linear or low-pressure polyethylene of the Ziegler or Phillips type has been reasonably firm at 35¢ for a comparatively long time. There are "off-grade" prices in this field, too—primarily for export or blending with conventional polyethylene. The base price of 35¢ applies to resins of 0.960 and 0.950 density with a melt index of 2.5 and above. General purpose black of this type is 37½¢, and colors or special blacks are 41 cents.

However, there are many variations in prices, just as with conventional PE. For example, the linear resins with a melt index of 2.4 and below, used primarily for bottle and blow molding, sell for 38 cents. Film grade resins in the 0.960- and 0.950-class, with a wide range of melt indexes, also sell for 38¢ a pound. This type resin should not be confused with the special formulations in the 0.935- to 0.949-density range—which may be rubber-modified high-density resins at 40¢/lb.; electrical grade resins at 40¢ and over; blends of high- and low-density resins; and special conventional resin types. Prices for the last two will vary according to formulations.

There is no telling what may happen to prices of linear polyethylene or even polypropylene if the base price for conventional polyethylene is reduced. It is notable though that, except for housewares molding, the linear polyethylenes are gradually finding their own markets where competition with conventional polyethylenes is not overwhelming. However, it must be observed that low pressure (linear) producers are eager in their efforts to find out what the high-pressure producers are going to do about the price situation.

**Growth areas for linear polyethylene.** Largest portion of the estimated 90 million lb. of linear PE used in 1959 was for molding—mostly housewares. A great part was used in blending with conventional PE to give a density of from 0.935 to 0.940. The asserted reason for blending is to achieve a higher degree of stiffness and a glossier surface.

Coming along fast is the use of linear PE for detergent bottles. Estimates for consumption for this purpose in 1961 run all the way from 20 to 40 million pounds. The next big one for bottles should be bleaches, which is said to be an even larger market, but the 2 qt. and 1 gal. sizes, which make up a large part of this market, are still questionable.

Pipe is the chief outlet for one of the low-pressure resin producers. This is a stiff, high-molecular weight type that is expected to compete with other rigid plastic pipe, but it takes a long time to develop this market. Thin walled linear type is also expected to eventually compete with conventional PE pipe for agricultural purposes. **(To page 45)**

Thomas Tann, Extruded Plastics Dept. Head, and D. S. Watkins, Vice-President Sales, Chardon Rubber Company, Chardon, Ohio

# VYGEN® quality assures top performance

Consistency—bag after bag, lot after lot—that's why leading processors like Chardon Rubber Company prefer Vygen for dependable extrusion! Performance-proved in countless critical applications, Vygen specialized PVC resins are *right* for any job, regardless of size, equipment or technique. Vygen runs better and cuts rejects!

Just give us your extruding, molding or calendering problems and requirements... we'll show you how the Vygen family of dependable PVC resins can assure sales-building quality and uniformity in your products. Write today for valuable information and technical assistance!

**THE GENERAL TIRE & RUBBER COMPANY**
**CHEMICAL DIVISION · AKRON, OHIO**

*Chemicals for the rubber, paint, paper, textile, plastics and other industries:* **GENTRO SBR** *rubber* **GENTRO-JET** *black masterbatch* • **GEN-FLO** *styrene-butadiene latices* • **GEN-TAC** *vinyl pyridine latex* • **GENTHANE** *polyurethane elastomer* • **ACRI-FLO** *styrene-acrylic latices* • **VYGEN PVC** *resins* • **KURE-BLEND** TMTD *masterbatch* • **KO-BLEND** *insoluble sulfur masterbatch*

## VYGEN specialized PVC resins

**Vygen 85** —A low-molecular-weight resin for processing at reduced temperatures

**Vygen 105** —A medium-molecular-weight resin—produces high-gloss finish

**Vygen 110** —General-purpose resin—has excellent heat and light stability

**Vygen 120** —A high-molecular-weight resin—ideal for dry-blend operations

**Vygen 123** —An extra-high-molecular-weight resin for dielectric heat-sealing applications

**Vygen 161** —An average-molecular-weight resin with high rate of plasticizer absorption

*Creating Progress Through Chemistry*

Chemical Division GENERAL

# THE PLASTISCOPE

(*Continued from page 43*)

Heavy duty bags for keeping out moisture, which are made from rubber-modified linear PE, are growing in use but not sensationally.

Comparatively new formulations for wire and paper coating are now being exploited but are small volume at the moment. They would fit in where other plastics don't have high enough properties or where thinner walls or coatings are desirable.

Film is still a question mark, but there are those who insist it will still win renown.

**Capacity to produce.** Anyone attempting to guess total capacity for producing polyethylene in the U. S. (and Puerto Rico) today is going to be wrong tomorrow, for additions to old plants and announcements for new ones are constantly in the news. Furthermore, there are confusing factors, such as the separation of high- and low-pressure plants among companies who make both, and the separation between polyethylene and polypropylene in low-pressure plants where management may presumably make whichever one it chooses.

Today's guess on the total amount of high- and low-density that could be made in the U. S. is roughly 1½ billion lb. a year, of which over 300 million is low-pressure or linear. But sometime in 1962 that total figure could be over 2.4 billion, with over 400 million of it in low-pressure. And even before this item is in print, there could be other announcements of additional capacity or changes in the allotment between polyethylene and polypropylene in low-pressure plants, with present low-pressure producers already talking about expanding their capacities.

**New plants on the way.** Latest bombshell to hit the industry was Union Carbide's announcement of intent to build a 110-million-lb. plant for conventional PE in Puerto Rico to begin operation in 1962. The plant is obviously close to a good market in Latin American countries, but it is also close to the U. S. mainland; and, since there are no trade restrictions between U. S. and Puerto Rico, its capacity should be counted in the total for the United States.

Only last September Carbide announced a 170-million-lb. addition for its two Texas plants, and the 80-million-lb. plant in Whiting, Ind. came in last year. Put all these together with previous announcements, and Union Carbide should soon have capacity for well over 600 million lb. of high-pressure PE, as well as 55 million lb. of low-pressure material. Other companies with an announced or planned capacity of over 200 million lb. of both low- and high-density resins are U. S. I., 320; Du Pont, 320; and Dow, 232.

Two new producers have announced their intentions to jump into the polyethylene sea within the past six weeks. One, Foster Grant, is already a producer of polystyrene, acrylonitrile-styrene copolymer, and nylon 6 (caprolactam). The trade estimates initial capacity will be around 20 million pounds. The second was Rexall, which has announced a joint venture with El Paso Natural Gas Co. to begin production of ethylene, propylene, high- and low-density polyethylene and polypropylene in 1962 in a plant at Odessa, Texas. The polyolefin capacity was announced at 150 million pounds. The guess in the trade divides it as around 100 million for conventional and 25 million each for high-density polyethylene and polypropylene. (To page 47)

*Korris Molds 19 oz. High Impact, Polystyrene Slide Projector Cover on Natco 300*

# "We use Natcos on our tough jobs"

## Comments Andy Kramer, Korris Plant Superintendent

"At Korris Products, Inc., Lyons, Illinois we would have lost the job if it had not been for our Natco. It was a molding large in area that had to be free of sinks and weld lines. Because of Natco's precise control of plunger speed and pressure, we had no trouble in getting quality parts on fast cycles.

"Our operators like the Natco because parts are easy to remove, it's clean and doesn't get oil and grease on them, and it was designed for convenient working height for most operators."

Tough jobs in your plant can become profit making jobs on a Natco. Write for complete information.

NATCO

THE MOLDER'S MOLDING MACHINE

**NATIONAL AUTOMATIC TOOL COMPANY, INC.**
PLASTICS MACHINERY DIVISION
RICHMOND, INDIANA, U. S. A.

# THE PLASTISCOPE

(*Continued from page 45*)

**New Delrin price competes with metals.** At the new 80¢ price, Du Pont's Delrin acetal resin now costs 4.11¢ per cubic inch. This compares with 4.04¢/cu in. for nylon (at 98¢/lb.), 3.87¢/cu in. for zinc, 7.14¢ for brass, and 4.24¢ for better-grade alloy steel. But Delrin requires no finishing after molding. Finishing adds considerably to metal fabricating costs, and, no doubt, helps to explain why Delrin has been selected for the 2-lb. instrument cluster board for the new Valiant automobile, which previously took 9 lb. of metal. And as pointed out in these columns many times before, the price of Delrin is expected to decline steadily as users start adopting it in increasing quantities.

**Filler for polystyrene.** Use of a filler for polystyrene has never been particularly successful. It is already the lowest cost volume plastic and a filler to make it even lower seems incredible; but Godfrey L. Cabot, Boston, Mass., now believes that its experiments with Wollastonite will make it possible.

Wollastonite is a mineral form of calcium silicate. Cabot claims it can be incorporated into a polystyrene compound at up to 30% by weight and at savings in material cost of from 6 to 10% with essentially no degrading effect. High loadings reduce the surface gloss to a matte finish, which is often desirable. Increase of product density (its s.g. is 2.9) can also provide an advantage where increased "heft" is desirable, such as in industrial parts or children's toys. A cu. ft. of polystyrene with 30% Wollastonite would weigh 81 lb., compared to unfilled polystyrene at 65.6 pounds.

**Polypropylene film price down.** AviSun Corp. has reduced the price of polypropylene film in 10,000-lb. lots and over to 70¢/lb. In 1-mil gage it is now competitive with 1¼-mil medium-density and 1½-mil conventional PE film when it is used in large quantity, according to AviSun officials, who also state that it is now 23% below 300 MS cellophane bread wrap film.

Olefane (AviSun's tradename) is claimed to have double the tensile strength of conventional PE and thus can be used in thinner gages with sufficient stiffness to make it workable on any wrapping machine that will handle thermoplastics. Such machines are now said to be available or other machines can be converted by placing moving belts over the heat-seal area.

The film is now being used in the Philadelphia area on paper products, such as paper plates and for bread, where its properties give excellent moisture protection.

**Vinylidene fluoride.** Another fluorocarbon resin, but one quite different from Teflon or Kel-F, will soon be available in pilot quantities from Pennsalt Chemicals, Philadelphia, Pa. The new resin, called RC-2525 Resin, is vinylidene fluoride. It contains over 59% fluorine. All fluorocarbons are notable for stability, and RC-2525 is no exception. It should in no sense be confused with vinylidene chloride, since fluorine-to-carbon bond is more stable than chlorine.

RC-2525 Resin has particularly good chemical resistance to acids, bases, and most solvents, although it can be dissolved by dimethylsulfoxide and dimethylacetamide, and partially dissolved by acetone. Pennsalt spokesmen say that it can be either compression or injection molded more (**To page 49**)

# Experience builds confidence

## This is a story about FOAMS... urethane foams

POLYETHER-BASED URETHANE FOAMS, chalking up new successes and spawning new applications at a remarkable rate, are fast becoming one of industry's most exciting developments. Their low cost, ease of application, and variety of forms (ranging from supple flexibility through semi-rigid to most rigid types) have tickled the imagination of thousands. Here are some developments to date:

the widest range of desirable properties of any available industrial foam

more accurate control of degrees of toughness, resilience, weight per unit volume, shock absorbency, insulating properties

marked price advantages over polyester foams and foam rubber

a solvent-blown rigid urethane foam which can be applied with readily available standard portable hot-spray catalyst equipment

But, as with all new developments, experience is an all-important factor. It can prevent costly mistakes, fruitless evaluation, conserve priceless laboratory time, cut costs, and insure greater product satisfaction.

So, if you have an interest in urethane foams – either flexible, semi-rigid, or rigid types – consider these facts:

**1.** Wyandotte pioneered in the development of the polyethers that have greatly improved urethane foams, given them a longer useful life, lowered their cost, and offered a far wider range of desirable properties.

**2.** Wyandotte was the first to develop a sprayable solvent-blown polyether rigid foam.

**3.** Wyandotte has extensive urethane application and development laboratories cooperating with all manufacturers of urethane foams, and with prepolymer manufacturers on the latest urethane-foam formulations.

This valuable experience (and our facilities) are available to you if you make, wish to make, or use urethane foams as a part of your own products or processes. Just write us, describing your requirements in as much detail as possible. *Wyandotte Chemicals Corporation, Wyandotte, Michigan. Offices in principal cities.*

Wyandotte's urethane-foam raw materials include: PLURACOL® Series of Triols, used for one-shot flexible foams and for the preparation of rigid urethane foams; PLURACOL Diols, used for prepolymer-type flexible foams and to impart strength properties to one-shot flexible foams; TETRONIC® Polyols, for improved resilience and moldability; QUADROL®, a very reactive cross-linking agent and catalyst; DHP-MP, a catalyst with extremely low odor.

**Wyandotte CHEMICALS**

**MICHIGAN ALKALI DIVISION**

*PACING PROGRESS WITH CREATIVE CHEMISTRY®*

# THE PLASTISCOPE

(*Continued from page 47*)

easily than other fluorocarbons. It can also be easily extruded, and film can be formed by extrusion or from dispersions by spray coating or casting. Its use as a coating over metal is one of its many possibilities.

Key properties are strength and toughness, chemical resistance, weatherability, thermal stability, and low cold flow. The temperature range is from —80 to 320° F. A melting point of 340° F. permits fabrication at reasonably low temperatures. It will withstand short periods of heat (½ hr.) at 650° F. Its resistance to ultraviolet make it promising for coverings on outdoor materials such as cables. Specific gravity is 1.76. No price has been announced, but the trade guesses at about $3.00/lb. in large quantities, or considerably below that of other fluorocarbons, the lowest of which is now $3.60. A recent experiment consisted of wrapping fresh ground beef in the film and then heat-sealing and irradiating the package—the meat was still in eatable condition after exposure to ordinary room temperature nine months later.

**Another type of polyethylene film.** A combination of strength and clarity not available in other conventional PE film is the strong claim made by Du Pont for its new film said to be made by "a radically different manufacturing process." Various claims of this sort have been made by several companies in the last six or seven months, but Du Pont spokesmen say that the others have approached this "combination of properties" with a resin technique, and that even then one of the two properties generally has to be the lesser in order to get maximum for the other. The undisclosed Du Pont technique can be used with conventional resin, but no one except company technicians know how it is done and will never be told, according to company spokesmen.

One and a half-mil film from the 30-million-lb. plant at Richmond, Va. is said to have withstood 25% more drops than currently existing high-impact films of the same thickness, and 150% more drops than high-clarity film. The film is marketed for bag making and make-and-fill equipment only.

**Hercules plant at capacity.** The Hercules plant in Parlin, N. J. is now operating at capacity level of 60 million lb./yr. with a flexible arrangement where either polypropylene or linear PE may be produced. The new Lake Charles, La. plant will come in next January, starting with 60 million lb. but capable of going to 120. Among recent PP products are coffee baskets for a percolator, toilet seats, bristles in street sweepers, and brushes. The proposed merger with Beaunit has been cancelled.

**Nixon plant sold to Baldwin.** The assets and business of the Nixon Nitration Works, Nixon, N. J., have been purchased by Nixon-Baldwin Chemicals Inc. Nixon-Baldwin Chemicals Inc. was formed by Allen J. Baldwin, former president of Nixon Nitration Works, and George F. Blasius, president of Cary Chemicals Inc. Present policies will be maintained. Improvements and additions to facilities will be made as soon as possible.

**For additional and more detailed news see Section 2, starting on p. 194**

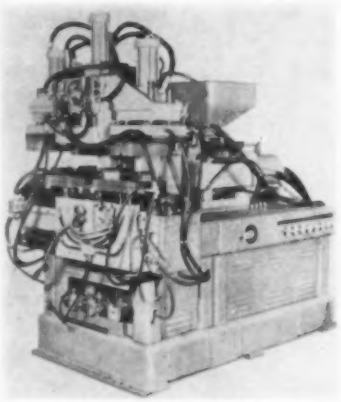
# NEW MACHINERY-EQUIPMENT

**Specifications, claims made, and prices appearing in these pages are those of the manufacturers or sellers of the machinery and equipment described, or their agents.***

### Blow molding machine

Known as the Model 1246 Duplimatic Blowmolder, this machine is a departure from the more common blow molding machine which uses an extruder and manifold valve system to produce parisons. Completely automatic and self-contained, this machine injection molds a parison on a core, transfers the core and parison to a blowing mold, blows the product, and ejects it, then repeats the cycle. Suitable for the production of a variety of plastic bottles, jars, toys, and irregularly shaped products, the machine has a major advantage in bottle manufacturing in that threaded bottle neck sections are molded to final shape and size integrally with the parison, eliminating the need for reaming and trimming the bottle after ejection from the machine. Also, since parisons are injection molded to approximately the finished shape of the bottle, heavy bottoms and the need to trim "pinch-off" are eliminated; and bottles can be produced having more uniform walls. The machine has been designed to require only the minimum of operator's attention, and is equipped with electric and hydraulic safety interlock systems to insure that bottles and operator's hands are completely out of the machine before recycling. Latest machine design techniques are incorporated into the construction of the unit, including unitized construction for easy maintenance. A separate operator console uses "plug-in" electronic timers, relays, and temperature controllers as well as what is said to be the largest printed circuit of its kind. All operating valves are manifold mounted and connected to the electronic control circuit by plug-in sockets.

The operation of the machine centers about the use of an ingenious laterally traversing parison core table which shuttles from right to left between two sets of blowing molds and a centrally located parison molding station. At the start of the cycle, one set of parison cores is clamped in the right hand blowing mold. (On the very first cycle these parison cores will have no plastic parison on them.) Parisons are then injection molded on the cores by means of the conventional injection system which is part of the machine. After injection is complete, all molds open and the traversing table moves parison cores to left-hand blowing molds. Simultaneously **(To page 52)**



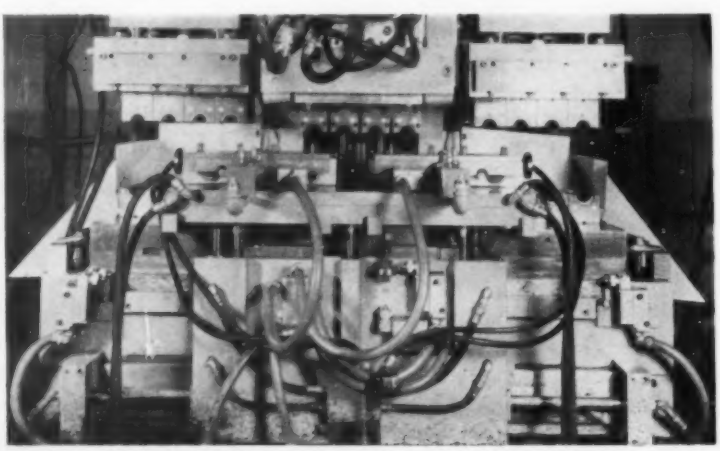
**MOSLO** Model 1246 Duplimatic Blowmolder is a completely automatic injection type blow molding machine. Shifting parison table and two mold stations are shown at left center. Injection cylinder for the molding of parisons is shown to the right under the feed hopper.

**Specifications:** Model 1246 Moslo blow molding machine

| | |
|---|---|
| Injection shot capacity, oz. | 4 to 6 |
| Dry cycles per hr. | 625 |
| Injection rate, cu. in./sec. | |
| With booster | 9.36 |
| Without booster | 2.62 |
| Injection ram diameter, in. | 2 |
| Injection stroke, in. | 8 |
| Maximum injection pressure, p.s.i. | 20,000 |
| Plasticating capacity, lb./hr. | 125 |
| Parison mold size, in. (top and bottom) | $10 \times 11\frac{1}{2} \times 5$ |
| Blow mold size, in. (top and bottom) | $10\frac{7}{8} \times 14 \times 5$ |
| Mold opening, in. | 6 |
| Mold clamp, tons | 90 |
| Maximum mold casting area, sq. in. | 40 |
| Operating cylinder temp. range, °F. | 150 to 650 |
| Injection cylinder heaters, w. | 11,000 |
| Nozzle manifold heaters, w. | 2,000 |
| Heater voltage, v. | 230[a] |
| Control circuit voltage, v. | 115[b] |
| Motor voltage, v. | 230/440/550[c] |

[a]3-phase 60 cps. [b]Single phase 60 cps. [c]3-phase 50 or 60 cps.

* Prices are deemed to be F.O.B. sellers' plants (unless otherwise stated), are for "standard" models, and are subject to change without notice. The publishers and editors of MODERN PLASTICS do not warrant and do not assume any responsibility whatsoever for the correctness of the same, or otherwise.



**CLOSE-UP OF THE FRONT** of the machine, showing cooling lines' connection to the shifting parison table. Parison molds are seen between two sets of bottle blowing molds mounted on the upper platen.

# NYLON?

# VAN DORN Presses mold it better

*because-*

1. Better material control
2. Close tolerances easier to maintain
3. Lower mold investment
4. Less waste in purging
5. Automatic cycling

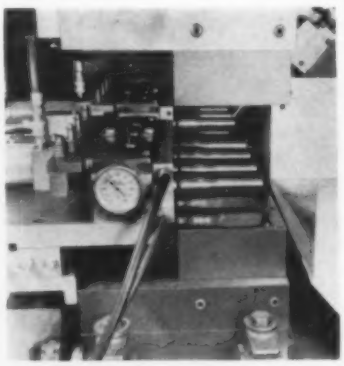
Many additional outstanding features of Van Dorn Presses are described in literature available on request.

THE Van Dorn IRON WORKS CO.
2685 EAST 79TH STREET CLEVELAND 4, OHIO

## NEW MACHINERY

*(From page 50)*

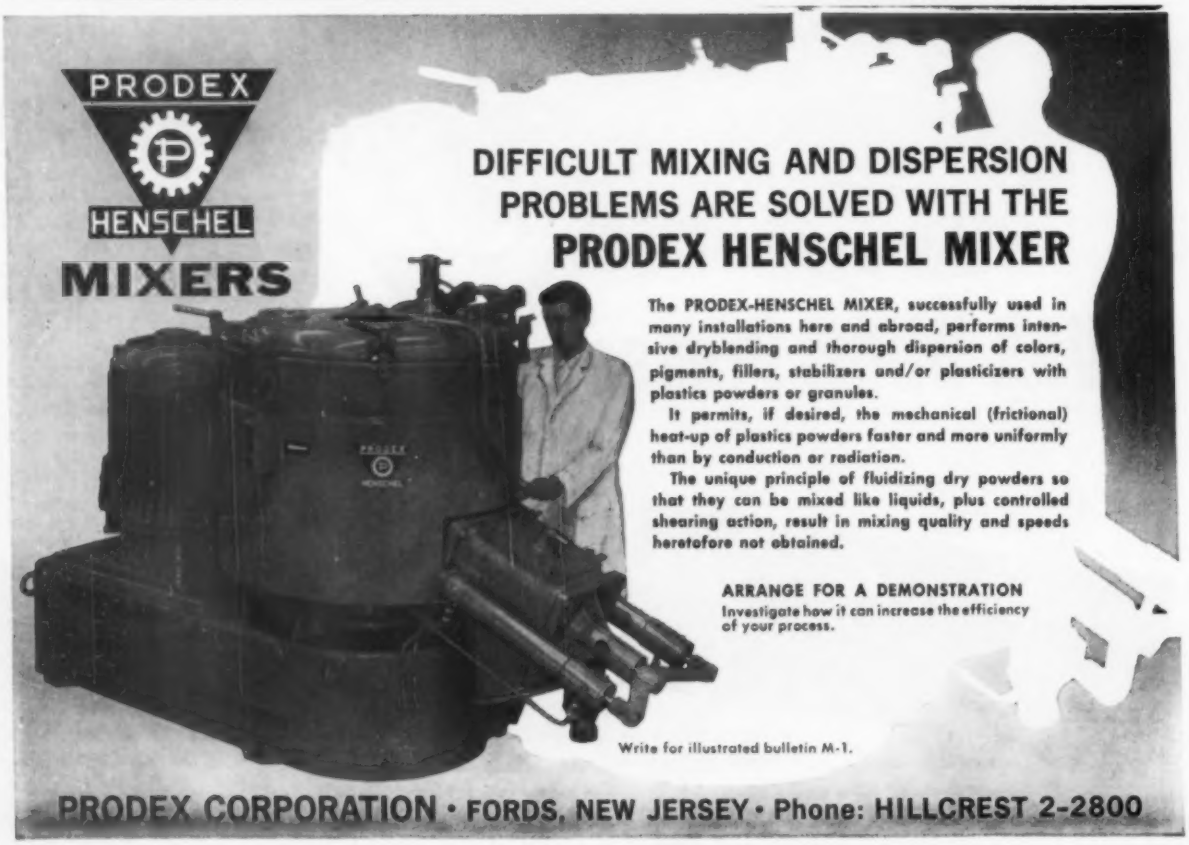
(since they are mounted on the same table), the parison cores which were in the right hand blowing mold are moved and positioned in the parison molding cavities. Molds then close, the bottles on the left are blown and parisons are molded onto the right hand set of parison cores. After the blown bottles on the left cool, molds open and the blown parts are mechanically and air ejected. Then the table shifts to the right to repeat the cycle. Depending on the weight and shape of the items to be blown, the parison holders are designed to accommodate 1 to 6 parison cores. The Duplimatic Blowmolder mold mounting plates and parison holders are designed to handle most any type of mold or parison system. Water and air connections are built into the mold mounting plates and parison holders so that cooling water and air supply lines can be permanently connected. Thus, if desired, the molds and parison systems can be mounted without individual air and water connections to each mold, eliminating the need for coring in the mold proper and simplifying the changing and set-up for molds by eliminating the need for dismantling air and water hoses. Thus, once the unit has been installed and main electrical, air and water connections have been made, there is no further need to dismantle air and water lines in production. Simple in design and construction, the Blowmolder requires a minimum of plant floor space and is engineered to take the exacting requirements of high speed, fully automatic operation; it is so automatic that an entire battery of these machines can be tended by one trained operator. Patents are applied for, but the unit is available to customers on a royalty-free basis. *Moslo Machinery Co., 2456 Prospect Ave., Cleveland 15, Ohio.*



**SIDE VIEW** of the parison holders, shifting table and fixed bottle mold station. After cooling, parts are mechanically stripped and air ejected into chute at extreme right center.

### PE bag plant

Called the Bag Line, an integrated system of production equipment which starts with the resin granules and delivers finished printed bags at the other end of a straight-line continuous-flow operation, has been developed. It can make plastic bags up to 21 in. wide and a maximum of 24 in. long, from film up to 4 mils thick, printed in one to four colors, with or without vent holes at production rates up to 120 bags/min. First, resin is extruded by the blown-film process. One surface is then electrostatically bombarded to treat it for good printability. The film is then printed and then passed through an "oven" to dry the ink. It is then fed continuously into a bag-maker, where vent holes (if desired) are punched, one end of the tube is heatsealed, and the bags are cut to length. They are then stacked automatically in two piles; the bag-maker has **(To page 54)**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MIXERS
DIFFICULT MIXING AND DISPERSION PROBLEMS ARE SOLVED WITH THE
PRODEX HENSCHEL MIXER
The PRODEX-HENSCHEL MIXER, successfully used in many installations here and abroad, performs intensive dryblending and thorough dispersion of colors, pigments, fillers, stabilizers and/or plasticizers with plastics powders or granules.
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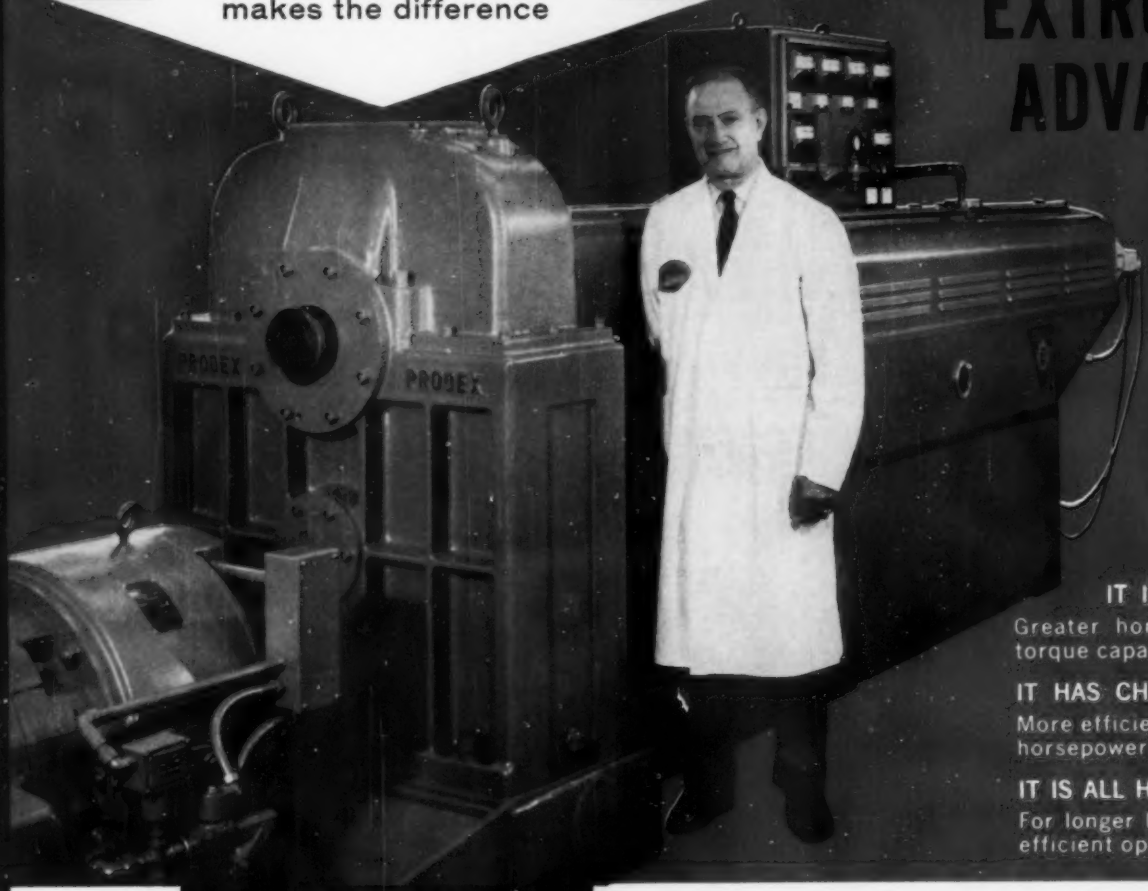
NEW!

# HIGH TORQUE GEAR REDUCER

makes the difference

# —ANOTHER PRODEX EXTRUDER ADVANCE




**IT IS STRONGER**
Greater horsepower and torque capacity.

**IT HAS CHANGE GEARS**
More efficient use of horsepower.

**IT IS ALL HERRINGBONE**
For longer life; for silent, efficient operation.

## LOOK AT THESE HORSEPOWER RATINGS *

| | 2½ | 3½ | 4½ |
|---|---|---|---|
| MINIMUM REDUCTION | 42 HP @ 195 rpm | 92 HP @ 138 rpm | 160 HP @ 116 rpm |
| MAXIMUM REDUCTION | 20 HP @ 86 rpm | 45 HP @ 60 rpm | 68 HP @ 47 rpm |

* including service factor for continuous operation

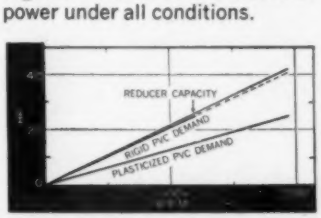
Many materials with a low viscosity can be run at high screw speeds without danger of overheating. Others, with high viscosity, must be run at lower screw speeds and require higher torque.

The new PRODEX **HT** EXTRUDERS permit you to run both extremes at maximum horsepower efficiency and output because of their high torque gear reducer with change gears.

See the new PRODEX **HT** EXTRUDERS perform with your own materials in our customer service laboratory. Write or phone for an appointment.

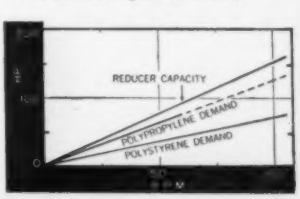
**EXAMPLE 1.**

The new 2½" PRODEX **HT** EXTRUDER with a 25 HP Dynamatic drive and gearing for 200 rpm speed, readily delivers 250 lbs/hr of plasticized PVC. For rigid PVC, change gears for 120 rpm max. screw speed are used to produce 150 lbs/hr at 80 rpm. Without the change gear provision, a 40 HP motor would have been necessary to provide adequate torque for the rigid PVC. Consequently there would be a higher initial cost, together with a severe waste of power under all conditions.




**EXAMPLE 2.**

The new 4½" PRODEX **HT** EXTRUDER, equipped with a 75 HP Dynamatic drive and gearing for 90 rpm max. screw speed, turns out 650 lbs/hr of high impact polystyrene without predrying. In order to run polypropylene M.I. 0.2, change gears for 65 rpm max. speed are used to deliver about 500 lbs/hr of this material. Without change gears, this machine would need a 125 HP drive, which would result in a substantial horsepower waste.




## PRODEX CORPORATION

**FORDS, NEW JERSEY · Phone: HILLCREST 2-2800**

IN CANADA: Barnett J. Danson & Associates, Ltd., 1912 Avenue Road, Toronto 12

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PRODEX
—in design and performance
ALWAYS A YEAR AHEAD

# NEW MACHINERY-EQUIPMENT

*(From page 52)*

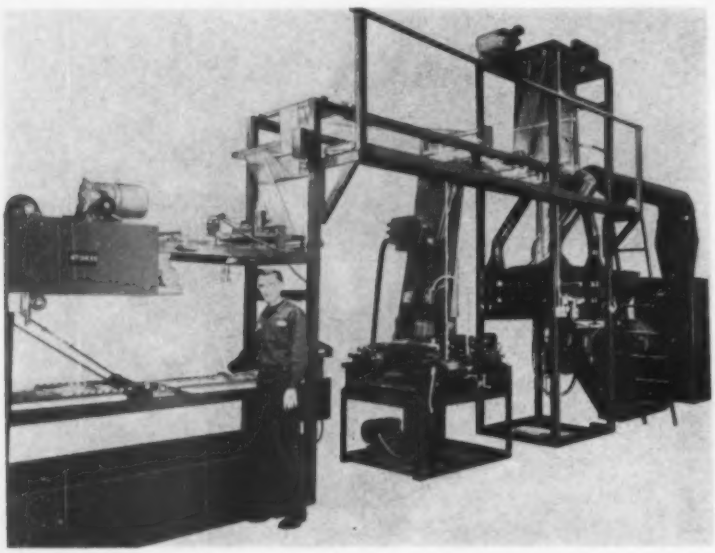
to stock only one basic raw material —the resin—instead of many rolls of film. This allows him to gain the difference in price, eliminate the labor of loading and unloading roll stock, and save valuable storage space. Concern about film variation is removed, as well as the waste caused by having to order more printed film than is actually needed, to be sure of an ample supply. Integrated controls constantly coordinate process conditions and compensate for variations as they arise. Production can be geared closely to requirements. Film thickness, bag width, length, printing copy, colors, can be quickly and easily changed. A unique clutch and brake arrangement assures accurate control over bag length and the position of the printed copy. Sealing unit is designed to give strong, dependable seals that are completely separated from the cut edge. A small fixed distance between the sealer and the cutoff maintains an exact and constant skirt length. Nearly 500 vent hole locations are possible by means of adjustable punching set up, designed so that the vent holes can always be located to miss important printing areas. The plant is supplied as a complete system—no additional equipment is needed. The manufacturer supervises the erection and startup, trains the operators, provides technical service to the user, and works with him in every way to assure efficient, economical bag production. *F. J. Stokes Corp., 5500 Tabor Rd., Philadelphia 20, Pa.*

### Vacuum systems

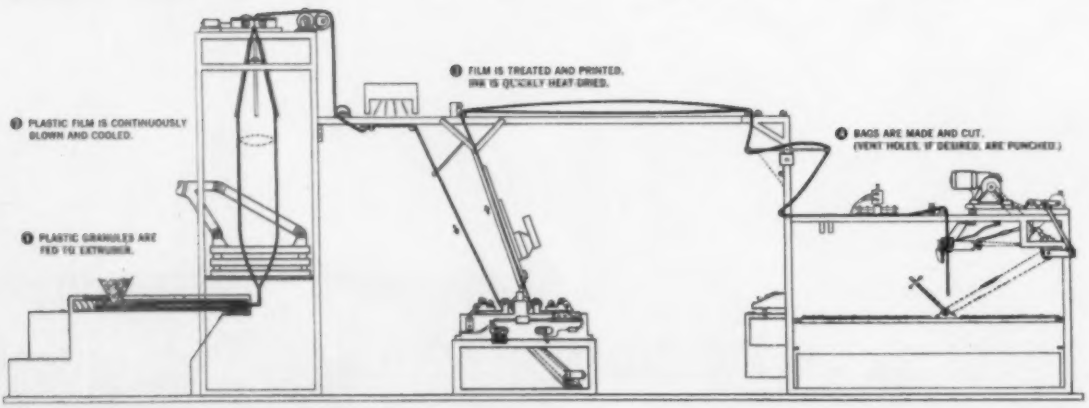
Two high vacuum systems, which can produce a low ultimate pressure of $2 \times 10^{-6}$ mm. Hg, are designed for research and development, where functional vapor deposition or general high vacuum processes permit the use of an evacuated chamber with 14- or 18-in. diameter. Designed primarily for vacuum coating they are also useful for studies in environmental testing, outgassing, etc. The LC1-14B system (14 in. chamber) reaches a working pressure of $5 \times 10^{-4}$ mm. Hg in 5 min. with a 6-in. PMC diffusion pump and a 13 cu. ft./min. mechanical roughing pump. The customer receives as standard, a Pyrex chamber, stainless steel baseplate with attached gate valve, PMC oil diffusion pump, manifold with backing and roughing ball valves, chevron-type baffle, flanged connectors for attaching a suitable mechanical pumping assembly and necessary electronic circuitry. A large number of standard options and accessories are available to provide a customized vacuum system to suit a variety of individual needs. *Consolidated Vacuum Corp., 1775 Mt. Read Blvd., Rochester 3, N. Y.*

### Thermocouple wiring

Multi-Lead T/C extension wire consists of multiple pairs of thermocouple extension wires harnessed into special cables. The cables can cut the cost of thermocouple wiring in plastic process instrumentation by reducing installation and maintenance time, saving space, cutting material costs, and lowering final installed costs. Multi-Lead T/C extension wire is supplied with from 4 to 48 pairs of extension wire per cable. All pairs are numbered, and supplied in lengths **(To page 56)**



**STOKES BAG LINE** (left) is shown with the blown film extruder at right. Cooling rings and blown film tower are immediately above the extruder. Film is printed (at center). Sealing, perforation, and bag cutting take place in unit at left, where bags are stacked next to the operator shown. Schematic flow diagram appears below. Black line is path of tubular film as it passes from extruder, through the printing and sealing units to the bag cutter and stacker at right.


1 PLASTIC GRANULES ARE FED TO EXTRUDER.
2 PLASTIC FILM IS CONTINUOUSLY BLOWN AND COOLED.
3 FILM IS TREATED AND PRINTED. INK IS QUICKLY HEAT-DRIED.
4 BAGS ARE MADE AND CUT. (VENT HOLES, IF DESIRED, ARE PUNCHED.)

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## (CYCLOHEXANONE)

One of the most powerful solvents available at a volume-production price, NADONE Cyclohexanone can cut the overall cost of solvent systems for organic coatings.

The addition of a small percentage of NADONE permits an increase in the volume of diluent that can be successfully incorporated in the solvent system. In nitrocellulose lacquers, for instance, NADONE solutions have a 6.3 toluene dilution ratio. Comparably high ratios obtain for other resins and diluents.

Conversely, NADONE solvent power makes possible higher solids content in resin-solution formulations.

An added advantage: Inclusion of NADONE prevents separation of resins and oils in solution and during evaporation of solvent from the film.

*U.S. Patent 2,389,608

**Other interesting, cost-saving uses of NADONE are:**

- As a detergent-additive in lube oils to minimize carbon and sludge formation.*
- To improve fractional solvent extractions.
- As a degreasing solvent or fortifier for lower-power degreasers.
- To make better paint removers, inks, adhesives, pesticides, etc., etc.

**WRITE FOR TECHNICAL BULLETIN I-19 F**

This 32-page bulletin gives details on these and other applications of NADONE, contains complete properties, reactions and a valuable list of 148 literature references. We'll gladly send you a copy of this bulletin and, if you wish, a liberal working sample of NADONE for your investigations.

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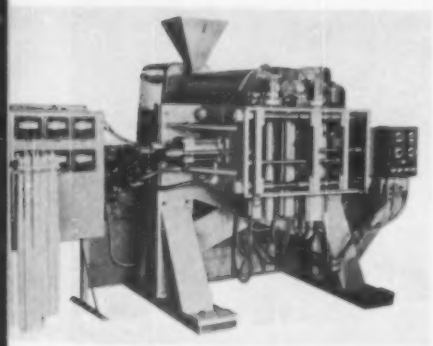
# NEW MACHINERY-EQUIPMENT

*(From page 54)*

up to 1000 ft. from stock. Additional pairs and longer lengths are available on special order. *Pyrometer Co. of America Inc., Penndel, Pa.*

### Blow molding machine

Designed for use with any extruder, the Trico Model 1216A blow molding machine can be supplied with either two- or four-parison nozzles. Dry



**ACME** Trico Model 1216A blow molding machine (four-head unit) shown with baseball bat mold that is mounted on the platens.

cycle time is about 2 seconds. Size of the vertical platens is 16 by 12 in., and the maximum platen opening is 10 inches. Separate clamp cylinder has a diameter of 24 inches. Automatic timing controls are provided on each platen and on air to nozzles. Maximum parison diameter on two-nozzle head is 3¾ in., and 2 in. on the four-nozzle head. Head temperatures are controlled by three West instruments. Machine is powered by 1000 p.s.i.—2 hp. Webster Electric Hydraulic system. Price without extruder: $8500 for the two-head unit; $3250 for the four-head unit. Distributed exclusively by the *Acme Machinery and Mfg. Co. Inc., 500 Saw Mill River Rd., Yonkers, N. Y.*

### Extrusion cutter

Model IV-S Versa Cutter for high-speed processing of extruded plastics now incorporates precision pinch-roll take-off synchronized with the action of the cutting blade. In addition to the new synchronized take-off, known as Versa Feed, the IV-S model has a redesigned Series 200 Reeves Vari-Speed Motodrive with wider speed variation, smoother operation and longer belt life. The Reeves unit is specially equipped with a 1½ hp. synchronous motor. The new pinch rolls, driven from the regular Versa Cutter motor through a variable speed transmission (to adjust length of cut) and through non-slip timing belts, can be used to replace the take-off unit on extruding machines, as well as to control the feed to the cutter. The Versa Feed pinch-roll take-off is also available separately, without drive, for use in a wide variety of feeding or pulling operations. A factory-installed, rear extension of the high-speed shaft has been added, and on this has been mounted a carefully balanced 20-lb. fly wheel as well as the driving pulley for the pinch-roll feed. The inertia of this rear fly wheel rotating at up to 4000 r.p.m., added to the inertia of the 40-lb. cutter head (also carefully balanced) rotating at about one-quarter of that speed, insures even greater precision in the intervals between cuts by eliminating any minor variations in speed or pulsations. All of the improvements in the new units can be installed on existing Model IV's of recent make. *Foster & Allen Inc., 26 Commerce St., Chatham, N. J.*

### Slitter-rewinder

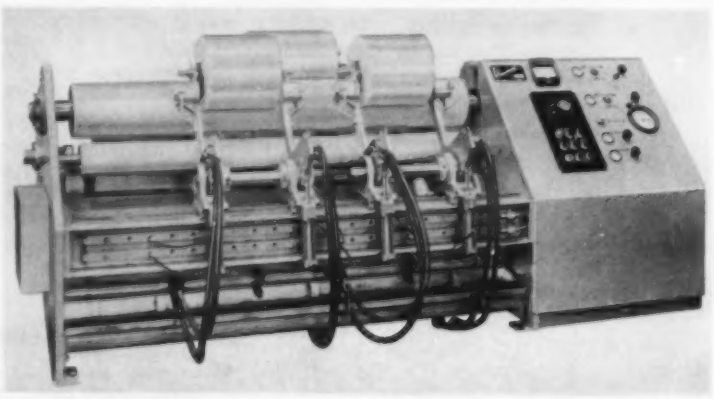
Model 800 Slitter-Rewinder is designed for handling all off-caliper plastic film materials. Each slit strip has its own rewind shaft and arms, giving positive contact with the surface winding drum and the controlled center rewind torque. The individual rewind shafts provide ease of unloading finished rolls. Loading is performed with equal facility, as there are no heavy mandrels to lift and no spacers to handle. The unit is designed for speeds through 1500 ft./min. and will handle and trim webs through 72 in. wide. Slitting is done by means of shear cut and/or razor blade. Score cut can be provided for special applications. Rewind diameter is 30 in. maximum. *John Dusenbery Co. Inc., 379 Allwood Rd., Clifton, N. J.*

### Torsion tester

Redesign of the Model CS-100 increases the capacity of the torsion tester from a single sample to 12 samples. The unit is used for determining the stiffness of nonrigid plastics over a wide temperature range. The Multi Torsional Tester is capable of exerting a torque of approximately 0.1 to 1.0 in./lb. on a test sample with a span of 1.5 inches. *Custom Scientific Instruments Inc., Kearny, N. J.*

### Tumbler

Designated Model XLC-2120, this plastic and metal parts finishing unit has the barrel mounted in a welded iron frame supported in oversize bearings at each end of the shaft. The hexagonal barrel is 20 in. in diameter, 21 in. long and lined with ¼-in.-thick neoprene. Based on individual needs, the barrel is supplied unlined, lined, or with abrasion-resistant rubber. The XLC-2120 can be utilized for wet or dry processes. Beneath the XLC-2120 barrel is a unique work and compound separation system. The top tank screen retains work while the barrel is unloaded. The screen allows the media to fall through to another screen directly beneath; this retains the media while only water and compound pass through. Barrels are supplied with two types of drives; constant speed (as desired) or variable in a ratio of 10:1. The gear head motor drive has a 24-hr. continuous rating and operates **(To page 167)**



**DUSENBERY** Model 800 Slitter-Rewinder showing the separate rewind shafts and arms for each reel of slit film. Control panel is at right.

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# WORLD-WIDE PLASTICS DIGEST*

**Abstracts from the world's literature relative to plastics. For complete articles, send requests direct to publishers. List of addresses is at end of this section.**

## General

*Packaging experts agree: market battle stiffening for film makers.* Chem. Week *86*, 116-18 (Apr. 16, 1960). Improvements in polyethylene film indicate that this plastic may gain a larger share of the packaging market. New films have greater clarity and toughness, are scented, shrinkable, and have higher gloss. A polyethylene netting as well as several developments in other plastic films are reported.

*High polymers in Red China.* Chem. Eng. Progress *56*, 140-42 (Mar. 1960). Recent theoretical and practical accomplishments in the fields of high polymers and synthetic rubbers in China are reviewed.

## Materials

*Synthesis and properties of polystyrene-acrylic acid graft copolymers.* P. V. Kozlov, M. M. Iovleva, and N. A. Plate. Vysokomolekuliarnye Soedineniia *1*, 1100-05 (July 1959). Graft copolymers of polystyrene and acrylic acid with varying component ratios were obtained by ozonizing polystyrene suspensions. The copolymer solubility diminishes and becomes limited as a result of the grafting. Investigation of the thermomechanical properties confirms the additivity for graft copolymers that was found earlier in the case of other systems.

*Photosensitive polymers. I. Cinnamate esters of polyvinyl alcohol and cellulose.* L. M. Minsk, J. G. Smith, W. P. Van Deusen, and J. F. Wright. J. Appl. Polymer Sci. *2*, 302-07 (Nov.-Dec. 1959). Cinnamic acid esters of polyvinyl alcohol and of cellulose are insolubilized by ultraviolet radiation. This response may be increased by the inclusion of simple organic compounds such as Crystal Violet carbinol and Michler's ketone. A method of measuring this response, based upon photographic sensitometry, is described. Preliminary study indicates that an increase in sensitivity value is accompanied by an increase in response to the longer wavelengths of light.

*Designing high-impact phenolic molded parts.* M. E. Hull. Product Eng. *31*, 54-57 (Mar. 7, 1960). Glass reinforcement raises the notched impact resistance of phenolic plastics to well over 2 ft.-lb./in. of width, so that they are suitable for products where shock loads are routine. Design rules are given for molded parts for dimensional accuracy, taper in molds, wall thickness, fillet radii, holes, threads, stiffeners, surface finish, choice of color, and labeling. Use of cellulose reinforcement produces lower sound transmisison and lower heat transfer than mineral fillers, while use of mineral fillers produces lower shrinkage during molding and better stability under conditions of heat and humidity.

*Reg. U. S. Pat. Off.

## Molding and fabricating

*Ionizing radiation used in making fluorocarbons adhesionable.* H. S. Stern. Adhesives Age *3*, 26-27 (Apr. 1960). Fluorocarbons are subjected to ionizing radiation from Cobalt 60 to render them bondable.

*Simplified process for making injection moldings with internal threads.* H. Gastrow. Kunststoffe *49*, 735-36 (Dec. 1959). A simplified process is described for designing dies with automatic unscrewing devices.

*Oxidation in extrusion.* R. C. Phelps and R. F. Kowal. Plastics Tech. *6*, 31-33 (Mar. 1960). Oxidation of polyethylene during extrusion reduces power factor and melt index, and increases carbonyl content, softening temperature, tensile strength, elongation, and density. Oxidation can be reduced by design of the equipment, blanketing of the extruder feed with nitrogen, and selection of extruding compound.

*Contour weaving gives 3-D preforms for reinforced plastics.* A. R. Campman. Product Eng. *31*, 47-51 (Mar. 21, 1960). A new technique for making glass fabric preforms used in reinforced plastic parts, called contour weaving, is described. The weaving is done on a programmed Jacquard loom with a take-up roll of varying diameter and produces preforms in a true three-dimensional shape such as a hemisphere or a honeycomb. For high production rates, parts using contour-woven preforms can be considerably cheaper than the same parts made by hand lay-up, even though cost per sq. ft. is three to five times that of flat cloth because the use factor on molds is high and fitting time is very low. For some applications, contour woven preforms are required to obtain uniform glass-to-resin ratios and dimensions in the molded part.

## Applications

*How Teflon improves surgeons' heart-lung machine.* A. W. Byxbee. Plastics Tech. *6*, 45-48 (Jan. 1960). Teflon parts are used in the construction of a machine for critical heart surgery.

*Distinctive plastic small car proposed.* Product Eng. *31*, 16-17 (Mar. 21, 1960). The feasibility of a new small car with a fibrous glass body on new chassis designed specifically to take advantage of the plastic body is described.

*Low-temperature strengths of metal adhesives.* NBS Tech. News Bull. *44*, 41-42 (Mar. 1960). The tensile-shear strength of four types of metal adhesives, epoxy, rubber-phenolic, vinyl phenolic, and epoxy-phenolic, were measured at various temperatures down to —424° F. The epoxy-phenolics containing glass fiber gave the best performance.

## Properties

*Electronic materials: Plastic foams.* Space/Aeronautics *32*, 174-77 (Nov. 1959). The properties of plastics foams are tabulated.

*Ultra-violet absorption spectrum of water stored in polyethylene bottles.* R. Delhez. Chemist-Analyst *49*, 20-21 (Mar. 1959). Redistilled water stored for several days in bottles used for several years for storage of redistilled water shows a pronounced UV absorption with a maximum at 270 millimicrons. This does not occur with redistilled water stored in glass.

*Wettability of solid surfaces by polymers.* V. A. Kargin, M. B. Konstantinopolskaya, and Z. Ia. Berestneva. Vysokomolekuliarnye Soedineniia *1*, 1074-76 (July 1959). The wettability of various solid surfaces by polymers was investigated. Most substances with surfaces differing in character are not wetted by polymers. This points out the different character of interaction by low molecular hydrocarbons and poly- **(To page 170)**

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# U.S. PLASTICS PATENTS

Copies of these patents are available from the U. S. Patent Office, Washington, D. C., at 25¢ each.

### U.S. Pats., Mar. 15, 1960

*Curing polyepoxides.* W. J. Belanger (to Devoe & Raynolds). 2,928,807-8.

*Epoxide resin.* D. D. Hicks (to Devoe & Raynolds). 2,928,809-10-11.

*Hydroxyalkyl carbamate-formaldehyde.* R. Ernst. 2,928,812.

*Chlorination of polyethylene.* H. Noeske (to Ruhrchemie). 2,928,819.

*Polyethylene.* G. F. D'Alelio (to W. R. Grace). 2,928,820.

### U.S. Pats., Mar. 22, 1960

*Plastics treatment.* E. A. Andrew (to Olin Mathieson). 2,929,107.

*Molding.* C. N. Cresap. 2,929,109.

*Plastic tubes.* A. Silverstein (to U. S.). 2,929,182.

*Spraying fibers and resin.* W. J. Hampshire (to Goodyear). 2,929,436.

*Polyvinyl acetal.* E. L. Martin (to Du Pont). 2,929,710.

*Irradiated polyethylene.* K. N. Mathes and H. I. Morgan (to General Electric). 2,929,744.

*Adhesive tape.* H. J. Stark, J. B. Alfers, and F. E. Cook. 2,929,754.

*Plastic turbine blades.* K. W. Porter (to Orenda Engines). 2,929,755.

*Polyvinyl chloride foam.* J. J. Hirsh. 2,929,793.

*Polyester-polyisocyanate-polysulfide composition.* E. Simon and F. W. Thomas (to Lockheed). 2,929,794.

*Aldehyde-diamine condensates.* H. E. Albert (to Firestone). 2,929,797.

*Polyurethanes.* F. B. Hill Jr. (to Du Pont). 2,929,800.

*Amide-urethane copolymers.* C. R. Koller (to Du Pont). 2,929,801.

*Filaments of polyurethanes.* M. Katz (to Du Pont). 2,929,802.

*Copolyureas.* A. H. Frazer and J. C. Shivers Jr. (to Du Pont). 2,929,803.

*Linear segmented polymers.* W. Steuber (to Du Pont). 2,929,804.

*Hydronopyl acrylate polymer.* C. S. Marvel and R. Schwen (to U. S.). 2,929,806.

*Copolymers of olefins and ethylene.* G. T. Leatherman and P. E. Campbell (to Phillips). 2,929,807.

### U.S. Pats., Mar. 29, 1960

*Plastic bookbinder.* P. J. Bardy (to General Binding). 2,930,054.

*Extrusion of cross-linked polyethylene.* J. E. Vostovich and C. A. Bailey (to General Electric). 2,930,083.

*Plastics from divalent metal acrylates.* R. P. Hopkins (to Rohm & Haas). 2,930,768.

*Foamed polyester.* G. A. Haggis and A. Lambert (to Imperial Chemical). 2,930,769.

*Cellular polyvinyl resins.* R. C. Wade (to Metal Hydrides). 2,930,770-1.

*Epoxy resin.* M. M. Renfrew and D. E. Peerman (to General Mills). 2,930,773.

*Diisobutylene - maleic anhydride salts.* D. B. Fordyce, C. L. Levesque, and W. D. Niederhauser (to Rohm & Haas). 2,930,775.

*Unsaturated polyester.* L. A. Lundberg (to American Cyanamid). 2,930,776.

*Vinylidene polymer composition.* E. K. Drechsel (to American Cyanamid). 2,930,779.

### U.S. Pats., Apr. 5, 1960

*Stretching polyterephthalate ester.* R. E. Kitson and C. E. Reese (to Du Pont). 2,931,068.

*Polytetrafluoroethylene extrusion.* D. R. Campbell (to Du Pont). 2,931,106.

*Shipping package.* A. M. Smith (to Texas-U. S.) 2,931,148.

*Oriented sheet.* W. H. Ryan and V. K. Walworth (to Polaroid). 2,931,-295-6.

*Expanded polystyrene.* E. A. Buck. 2,931,510.

*Glass fiber-epoxy laminate.* A. Marzocchi and N. S. Janetos (to Owens-Corning). 2,931,739.

*Flame-retardant polyester resin.* P. Robitschek and C. T. Bean (to Hooker). 2,931,746.

*Destaticizing agent.* M. A. Coler and A. S. Louis. 2,931,783.

*Polyester - vinylidene monomer.* K. W. Raymond (to General Electric). 2,931,784.

*Vinyl phenyl boronic ester polymers.* A. K. Hoffman and W. M. Thomas (to American Cyanamid). 2,931,788.

*Pinic acid polyamides.* E. A. Wielicki (to American Viscose). 2,931,789.

*Thermoplastic polymers.* J. A. Melchore (to American Cyanamid). 2,931,793.

### U.S. Pats., Apr. 12, 1960

*Polyethylene articles.* R. S. Aries. 2,932,323.

*Motion picture screen.* T. S. Harkness and O. K. Kolb (to A. S. Harkness). 2,932,581.

*Polyester - polytetrafluoroethylene resin.* A. N. T. St. John and B. M. Walker (to Resistoflex). 2,932,597.

*Printed circuit.* V. F. Dahlgren (to Sanders). 2,932,599.

*High fold endurance paper.* G. B. Sterling (to Dow). 2,932,603.

*Polyurethane foam.* S. M. Terry (to Pittsburgh Plate Glass). 2,932,621.

*Zirconium stabilizer.* H. M. Olson (to Harshaw). 2,932,624.

*Polyesters.* W. R. Burton and N. Standring (to Imperial Chemical). 2,932,625.

*Diepoxide polymers.* B. Phillips and P. S. Starcher (to Union Carbide). 2,932,626.

*Polymercaptan copolymer.* F. P. Greenspan and R. E. Light Jr. (to Food Machinery). 2,932,627.

*Polymers of bicyclo(2,2,1)-2-heptene.* I. M. Robinson, L. H. Rombach, and W. L. Truett (to Du Pont). 2,932,630.

### U.S. Pats., Apr. 19, 1960

*Metal-plastic firearm barrel.* J. L. Wilson (to Olin-Mathieson). 2,932,-915.

*Apparatus for depositing reinforced plastic.* D. F. Anderson (to Canadian Ingersoll-Rand). 2,933,125.

*Furfuryl alcohol polymer coating.* I. S. Goldstein (to Koppers). 2,933,-413.

*Deicing coating.* E. A. Fike (to Monsanto). 2,933,419.—End

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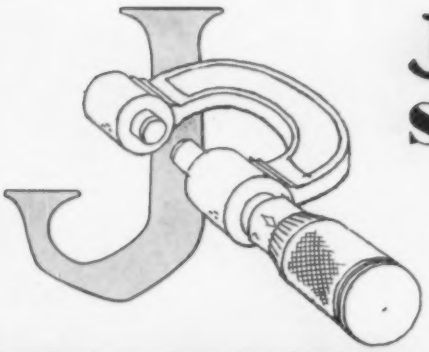

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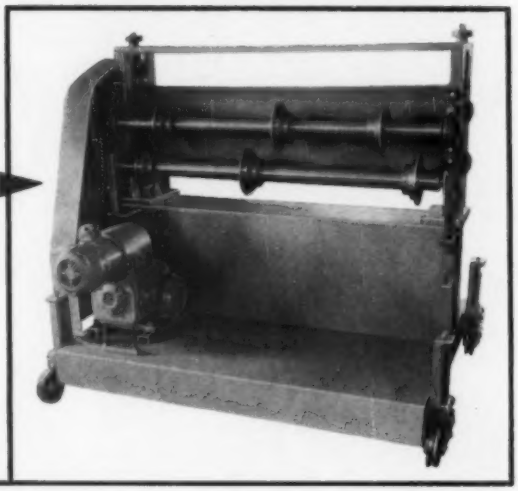

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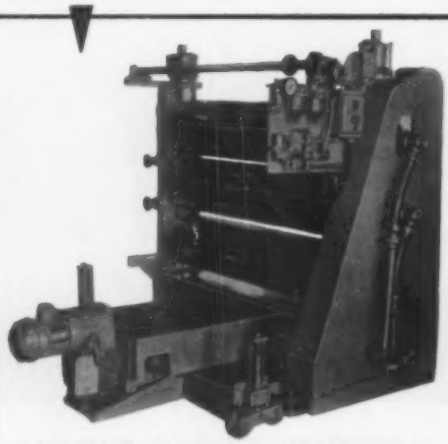

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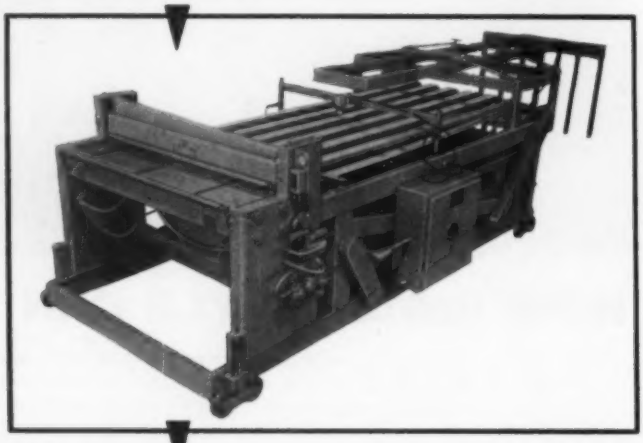

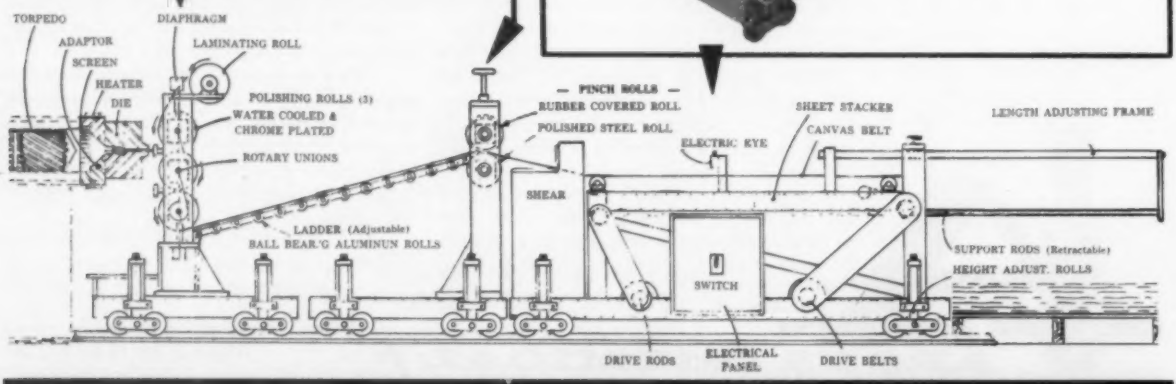


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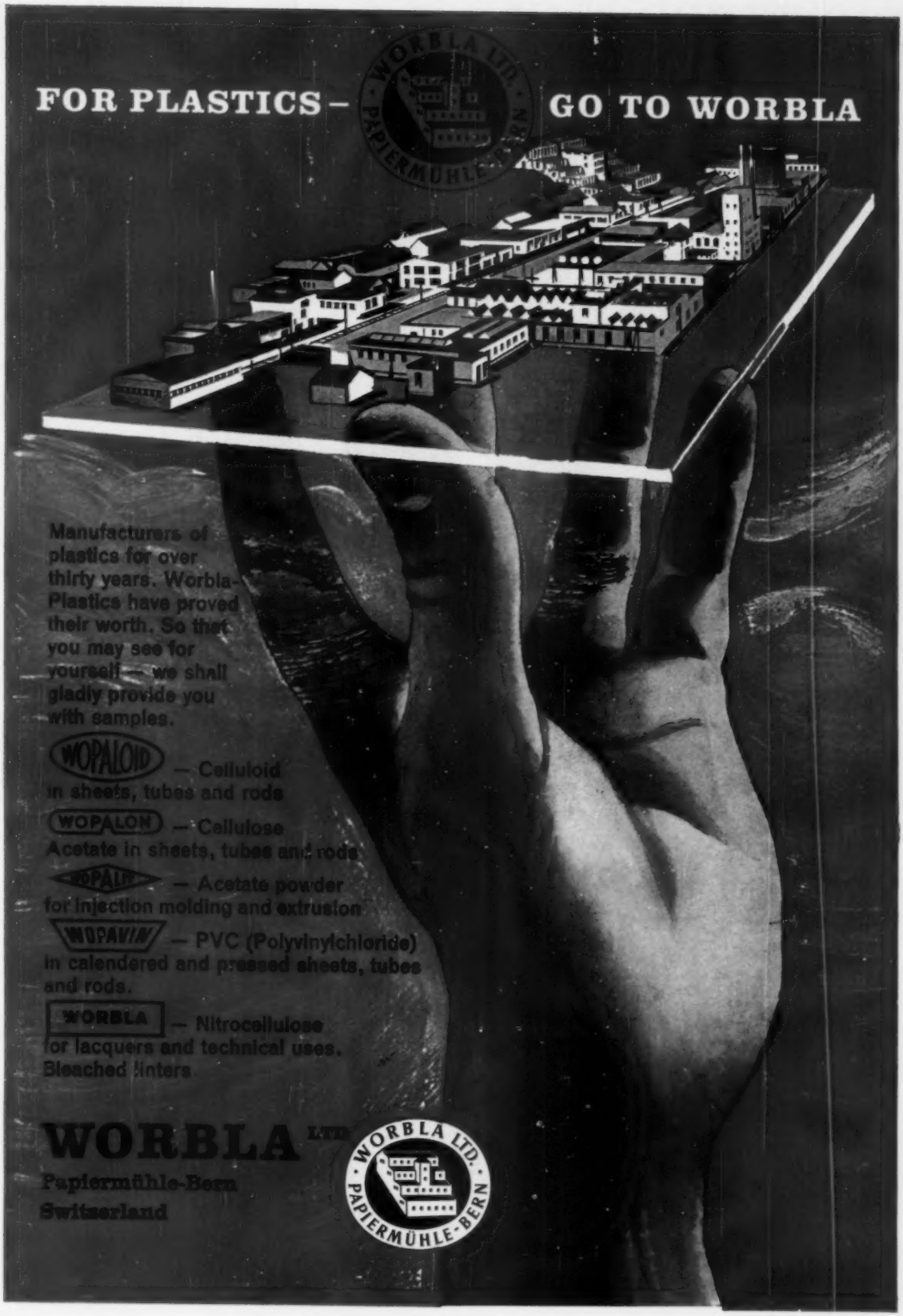


Manufacturers of plastics for over thirty years. Worbla-Plastics have proved their worth. So that you may see for yourself — we shall gladly provide you with samples.

WOPALOID — Celluloid in sheets, tubes and rods

WOPALON — Cellulose Acetate in sheets, tubes and rods

WOPALIN — Acetate powder for injection molding and extrusion

WOPAVIN — PVC (Polyvinylchloride) in calendered and pressed sheets, tubes and rods.

WORBLA — Nitrocellulose for lacquers and technical uses. Bleached linters

**WORBLA** LTD.
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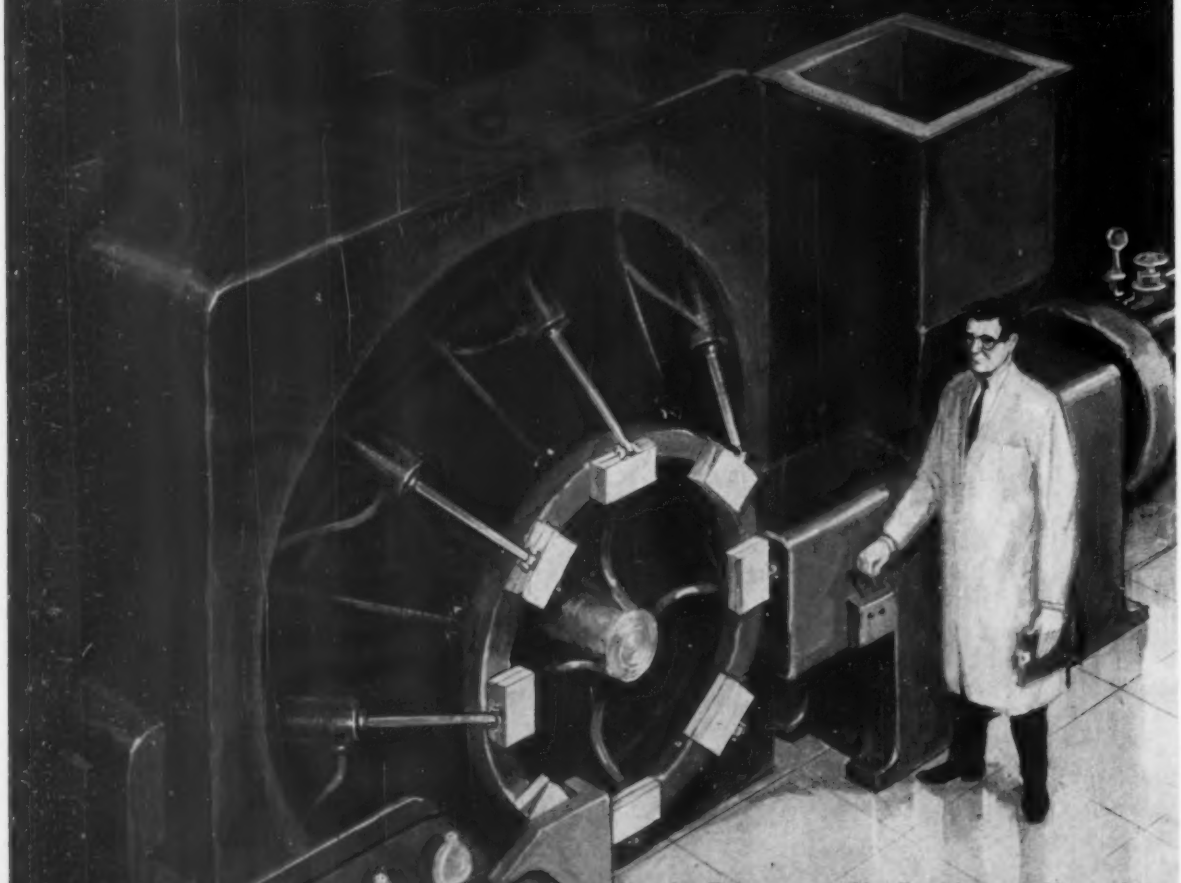
SIGNIFICANT ADVANCES IN BERYLLIUM TECHNOLOGY COME FIRST FROM BRUSH

# BERYLLIUM COPPER HELPS BLOW MOLDERS FILL HUGE DEMAND



**Cast beryllium copper molds allow shorter molding cycles, give longer, more economical production runs.**

Blow molders produced 500,000,000 polyethylene containers last year. This year, the big question seems to be, "Can they puff out enough containers to meet the expected one billion demand?" Molds made of beryllium copper offer part of the answer.

For mold makers, this Brush-supplied alloy is easy to cast to shape without expensive machining, simple to heat treat to hardnesses of Rockwell C44 and tensile strengths to 175,000 psi. For producers of plastics, tough beryllium copper molds last longer, reducing replacement downtime. The alloy's high thermal conductivity aids in shortening mold cycles for more output per machine hour.

Molds for plastics may not be your problem, but Brush may have the answer to some of your tough material requirements. For more information on beryllium, its oxide and its versatile alloys, contact us at 5209 Euclid Avenue or ENdicott 1-5400 in Cleveland, Ohio.

THE BRUSH BERYLLIUM COMPANY

# In Denmark, too, the best signs are made from 'Perspex'

*Three internally illuminated signs made from coloured and opal 'Perspex' sheet by Colorlux, Esbjerg, Denmark.*

IN DENMARK, as in so many countries, more cars fill up at signs made from 'Perspex' acrylic sheet. They're the best signs because they're gayer, brighter, *more eye-catching*.

'Perspex' can be internally illuminated; it is the ideal material for both exterior and interior signs. 'Perspex' retains its good looks regardless of weather conditions and atmospheric corrosion, and is easily cleaned.

An exciting range of colours is available in transparent, translucent and opaque sheet. Opal and clear 'Perspex' are also available.

**'PERSPEX'**

*'Perspex' is the registered trade mark for the acrylic sheet manufactured by I.C.I.*

**Imperial Chemical Industries Limited, Plastics Division: Export Dept., Black Fan Road, Welwyn Garden City, Herts.**

*U.S.A. enquiries to:* J. B. Henriques Inc., 521 Fifth Avenue, New York 17, N.Y.

*Canadian enquiries to:* Canadian Industries Ltd., Plastics Division, Box 10, Montreal P.Q.

P740/O/A

# NEW DEVELOPMENT

## DYNAMIC PREPLASTICIZER
## FAST INJECTION SPEED

## G. B. F. "PLASTINIECTOR"
world patent

moulds better
moulds faster
self-contained
fully automatic
oil hydraulic

**"PLASTINIECTOR 80"**
capacity: 4 oz.
7 c. inch

Other sizes available:
2- 6- 11 and 18-oz.

***ADVANTAGES:***

1. Uniform plasticizing and high injection rate at lower temperature.
2. Total pressure directly on the material.
3. Extremely fast injection.
4. Exact weight of each shot due to the volumetric injection of the preplasticized material.
5. Low injection pressure.
6. No change of container for the various materials and colours.
7. Automatic operation cycle regulable by timers and continuously controlled.
8. Parts better in quality and uniform in size, also on large areas and on thin walled sections.
9. Hourly plasticizing capacity:

| 2 oz. | 4 oz. | 6 oz. | 11 oz. | 18 oz. |
|---|---|---|---|---|
| 20 lbs. | 30 lbs. | 49 lbs. | 88 lbs. | 145 lbs. |

GBF

**COSTRUZIONI MECCANICHE s.r.l.**
**BRESSO** (Milano)—**Italy**
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*World Distributors:*

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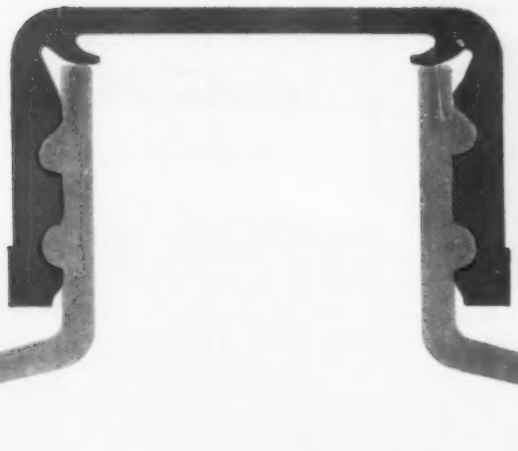


# NEW ONE-PIECE CAP HAS A BUILT-IN SEAL!

With the new UN-A-TOP* one-piece plastic cap, **you need no liner.** The integral seal seats perfectly on threaded can or bottle spouts. It automatically locks itself! Versatile UN-A-TOPS screw on and off easily, and they won't jump or strip threads. They are strong, rigid, won't chip or dent, and they are priced in line with metal closures.

New UN-A-TOPS are molded from SUPER DYLAN® high-density polyethylene. This strong plastic has a smooth, glossy finish. It is durable, lightweight, rust-proof, and highly chemically inert. It has low permeability, and good heat and dimensional stability.

UN-A-TOPS come in all sizes, shapes, and colors. They put extra sales appeal on top of any cosmetic, detergent, food, chemical, or pharmaceutical package.

For more information about UN-A-TOPS and SUPER DYLAN write to Koppers Company, Inc., Plastics Division, Dept. MP-7, Pittsburgh 19, Pennsylvania.

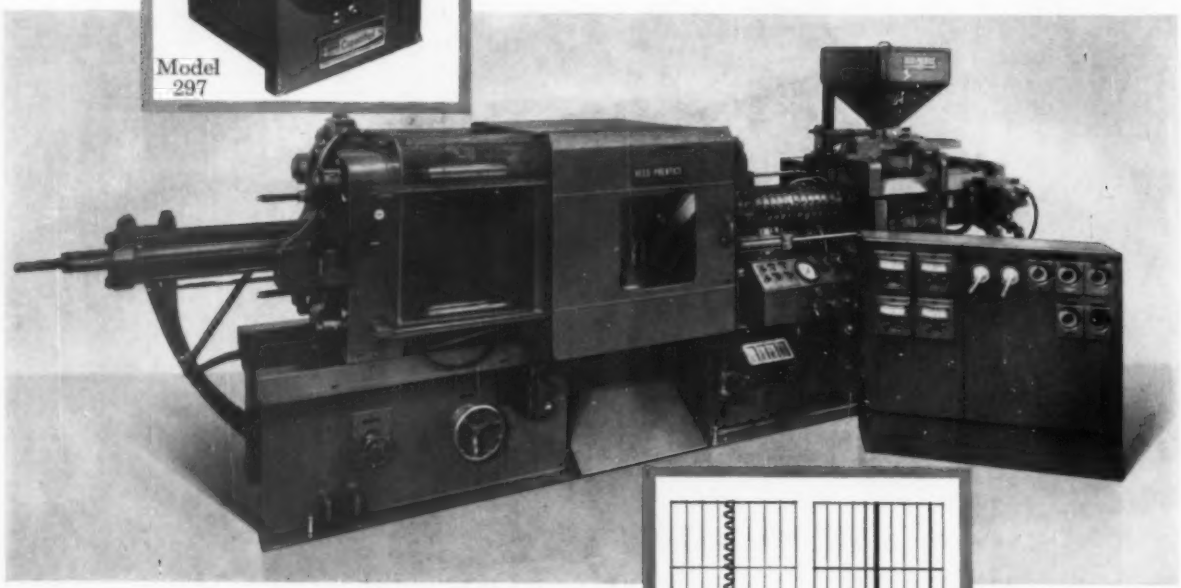
**KOPPERS PLASTICS**

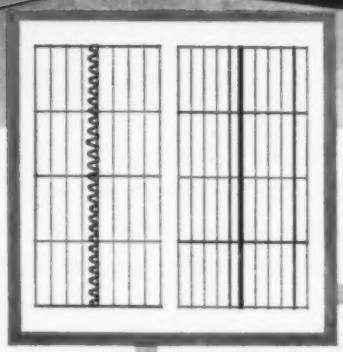
*Pat. Pending

UN-A-TOPS are molded by the Dover Molded Products Co., 1000 East Avenue, Dover, Ohio.

*another Wheelco specification story...*

Model 297





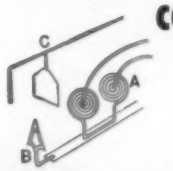
LEFT: Ordinary recorder with typical "on-off" control.

RIGHT: Wheelco "straight-line" Capaciline control.

# Wheelco Capacitrols specified by Reed-Prentice for new Injection Molder

Reed-Prentice, another leading original equipment manufacturer for the plastics industry, has specified Wheelco Model 297 Capacitrols for their new 350TCL-12/16 oz. injection molding machine. Why is Wheelco the overwhelming choice for plastics instrumentation? *User advantages.* Look at Model 297 Capacitrols for example — users get fast, accurate temperature control because of Wheelco's "Electronic Link" no-contact control. Plug-in terminal panels permit easy servicing without dismantling the instrument. "Straight-line" control is provided by built-in Wheelco Capaciline control. A wide choice of temperature ranges for plastics applications is offered. Thermocouple break protection can be supplied as an optional feature. Whether you are a plastics OEM like Reed-Prentice, or a user of plastics machinery, you can increase the efficiency of your equipment with Wheelco instrumentation. Contact your nearest Wheelco sales and service office for complete information. Wheelco has a complete line of process-control instrumentation to fulfill your requirements.

## Wheelco "Electronic Link" control




Wheelco "Electronic Link" provides safe, accurate "no-contact" control with no instrument lag. The frequency of an oscillating current flowing between two coils (A), which are mounted on the temperature setting lever (B), is changed when the metal flag (C) is moved by even a slight temperature change. Relay contacts are thus activated providing operation. This simplified design means little, if any, maintenance.

BARBER COLMAN

**Wheelco Instruments Division**
**BARBER-COLMAN COMPANY**
Dept. G, 1517 Rock Street, Rockford, Illinois, U.S.A.
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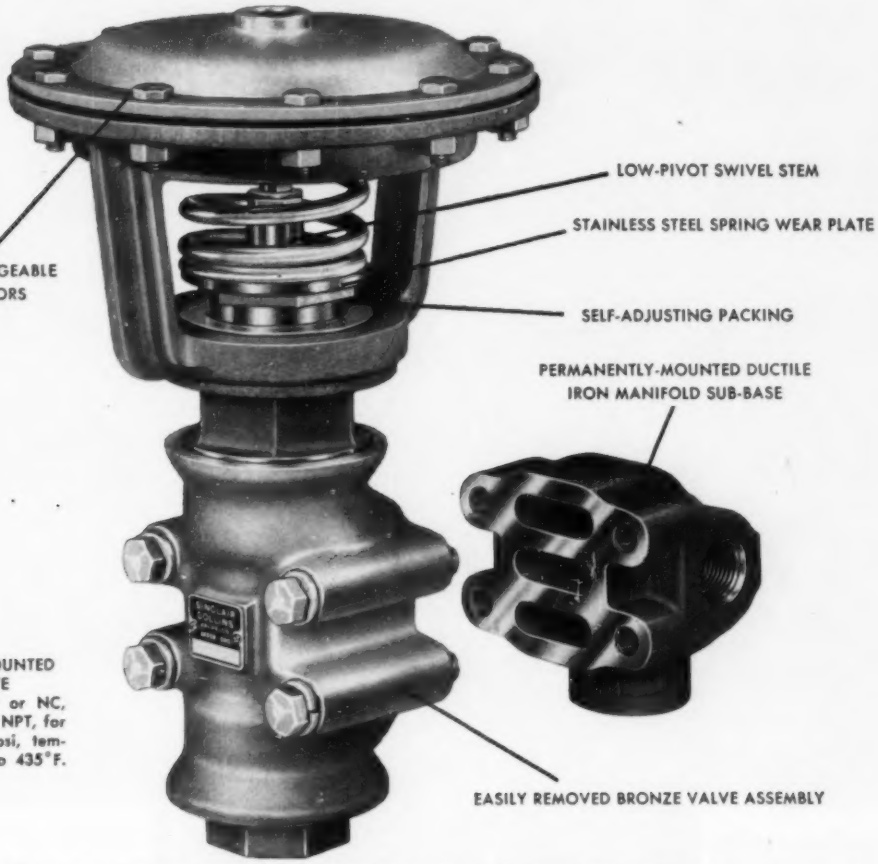
# NEW—SINCLAIR-COLLINS

## 1/2" manifold-mounted steam valve




**S-C MANIFOLD-MOUNTED STEAM VALVE**
2- and 3-way NO or NC, tapped ½- or ¾-in. NPT, for pressures to 350 psi, temperatures from 0 to 435°F.

Want excellent flow characteristics and bubble-tight sealing? Want maximum service life and minimum downtime for maintenance? Want compact, versatile design and ease of installation? Then you'll specify Sinclair-Collins' new manifold-mounted steam valve.

S-C's low-pivot hollow swivel stem places the pivot point *within* the extra-long bearing area to minimize side thrust and wear . . . provides maximum packer life. Self-adjusting spring-loaded Teflon chevron packing requires no attention. Piloting of all assembled components eliminates misalignment of stem. These features, plus Sinclair-Collins' precision manufacturing techniques are your assurance of long trouble-free valve life.

What's more, S-C's new valve can be converted from NO to NC, or vice versa, by rotating it 180° on the manifold sub-base.

Some day, maintenance will be necessary . . . it's simple . . . just loosen four mounting bolts, remove the valve for later bench servicing and install a replacement . . . downtime can be measured in minutes!

Find out how this advanced design valve can improve the performance of machines you have in service or on the drawing board. Your Sinclair-Collins field engineer has all the details.

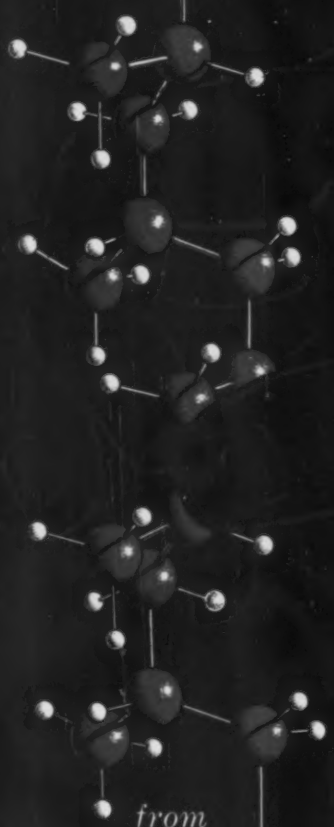
*For more information, write for free Bulletin MV-60. Address The Sinclair-Collins Valve Company, 454 Morgan Avenue, Akron 11, Ohio, Dept. MP-760.*

**The SINCLAIR-COLLINS VALVE Co.**
DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)
AKRON 11, OHIO

8128

# Moplen*

POLYPROPYLENE



*from*

## MONTECATINI

*milestone in the conquest of inner space*

Everywhere chemists are exploring the way molecules are put together... putting atoms together in exact, predetermined relationships with each other... producing spatially-ordered molecules . . . making useful products from these polymeric materials with designed-in properties for specific applications.

Leader in this conquest of inner space is Montecatini, who developed the first stereospecific polymer, MOPLEN® polypropylene. The forerunner of a revolutionary class of plastic materials discovered by Giulio Natta of the Polytechnic Institute of Milan, MOPLEN® is being widely used in Europe and in the United States.

Montecatini continues to explore this new world of structural chemistry . . . is developing new polymerization catalysts and producing new polymers with exciting potential as plastics, textile fibers and elastomers in the products of tomorrow.

Wherever you are in the world, you can put these discoveries to work for you. Look to Montecatini for MOPLEN® . . . and for new advances in the conquest of inner space.

Montecatini Trademark

MONTECATINI

SOC. GEN., MILANO, ITALY

U. S. and Canada Representative: CHEMORE CORPORATION • Two Broadway, New York 4, N.Y. • BO 9-5080

- **Hauls all profiles, tubes, cables without set-up**
- **Will not scratch, mar, mark or dull any finish**
- **Infinitely variable speed ranges from 4" to 445 ft/min.**
- **Instantly adjustable to any center line of extrusion and to any size extrusion up to 16"**
- **No slippage – highest safety factor of hauling power**

Plastic, rubber or metal . . . from the first foot out of your extruder to the last . . . the versatile Farris Universal Take-Off Machine hauls perfectly and without waste. Endless caterpillar belts with cellular-form blocks pull with little vertical pressure, permitting take-off of even the thinnest materials without distortion. Available in a choice of hydraulic or electronic drives and a variety of models for every extruding requirement. Every machine is backed by the internationally known and accepted Farris manufacturing, sales and service organization.

**HUNDREDS OF USERS SAY—**

"It is the most versatile type of Take-Off for use with plastic extruders..."

*"We can only say that we are highly delighted with its performance and would be very pleased to recommend it to any of your customers..."*

"We haul off tubes having very thin wall thickness (0.015") without distorting or damaging the tube..."

*"It is a very sound and straightforward engineering job..."*

"We appreciate its great flexibility in dealing with different sections and its ease of adjustment while running..."

WRITE, WIRE OR PHONE FOR OUR CATALOG
Complete technical data about Farris Universal Take-Off Machines. Ask for Catalog FM-110.

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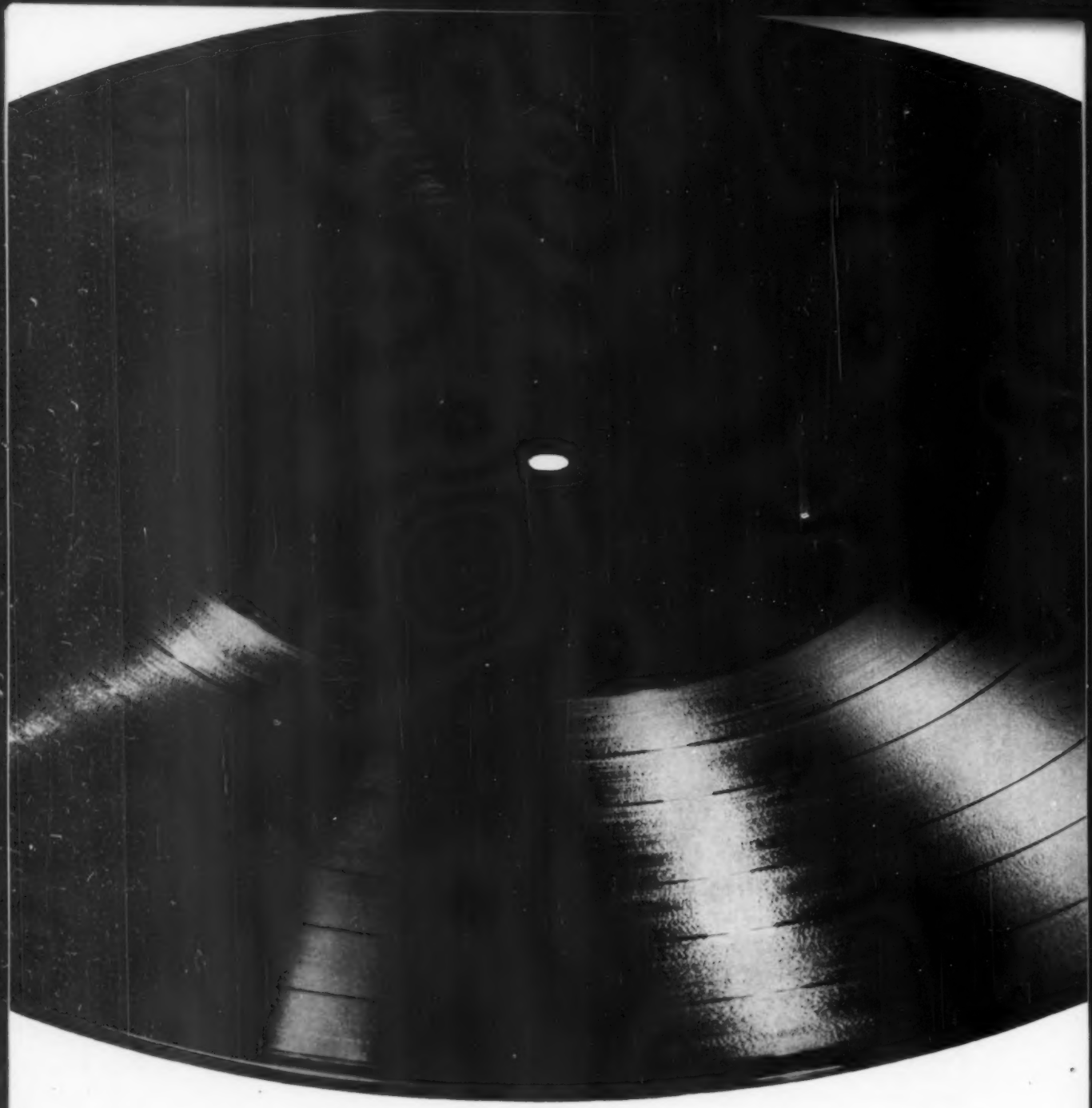

# MATTER OF RECORD

Of all the record resins available, Borden Chemical's VC161 is the choice of more and more producers of phonograph records. And for the best reason in the world: they get higher quality pressings at lower cost. *Bel canto* performance! But that's just the work of one Borden Chemical product. Borden copolymers can help you cut costs and improve the quality of records, vinyl-asbestos floor tiles, or many other vinyl products. Let us show you how. The Borden Chemical Company, Polyvinyl Chloride Dept., MP70, 60 Elm Hill Ave., Leominster, Mass.

THE BORDEN CHEMICAL COMPANY ©TBC

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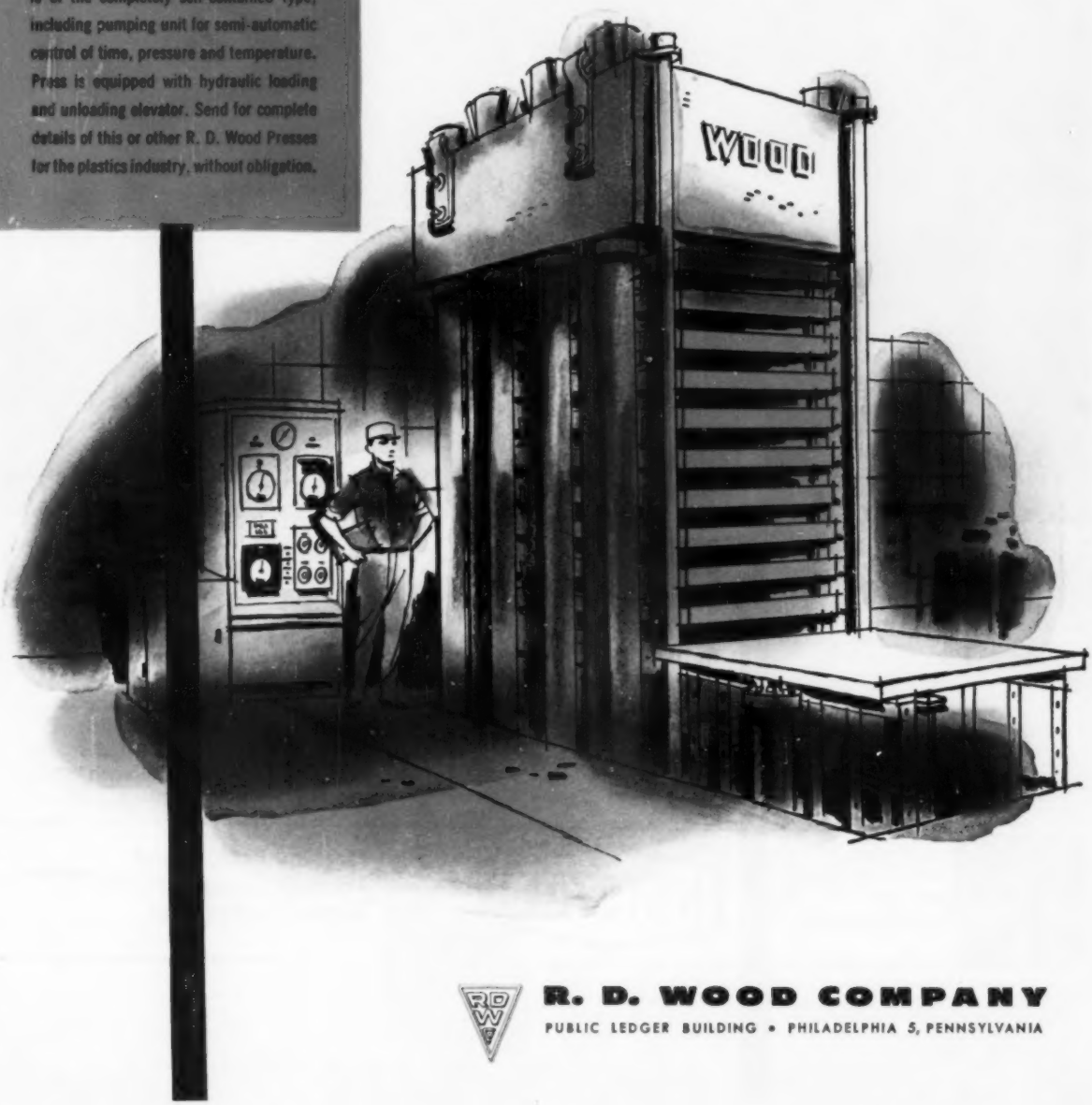
2,000-ton R. D. Wood Hydraulic Press for laminating and polishing plastics. Press has 10—4" openings, platen size 42"x83", and is of the completely self-contained type, including pumping unit for semi-automatic control of time, pressure and temperature. Press is equipped with hydraulic loading and unloading elevator. Send for complete details of this or other R. D. Wood Presses for the plastics industry, without obligation.

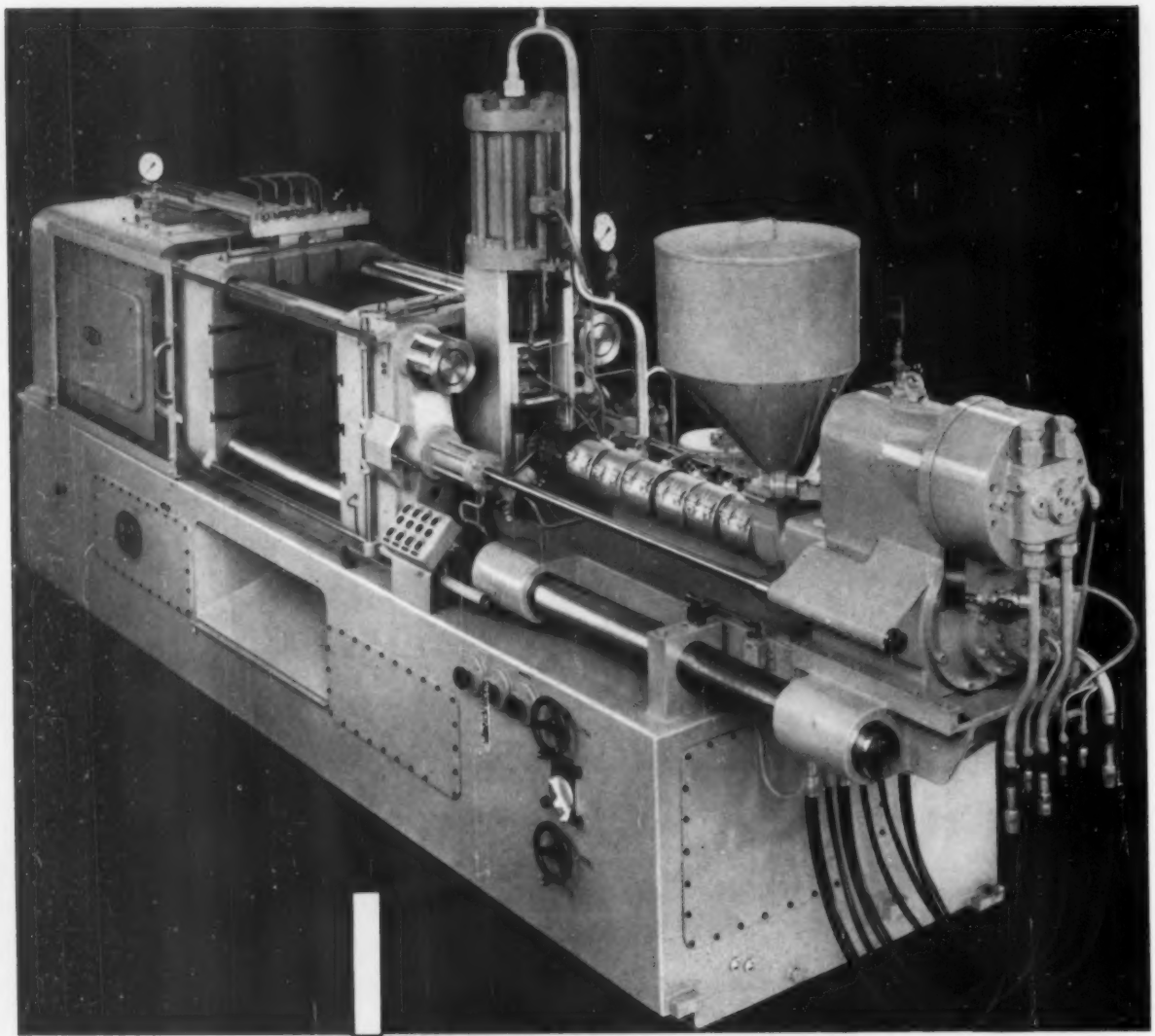
## *The most productive plants use R. D. Wood Presses*

For proof, look at production records—and downtime for maintenance. Then watch an R. D. Wood Press at work. See for yourself the smooth, precise operation—the dependable performance—even under tough conditions. Finally, inspect an R. D. Wood Press up close. Notice the soundness of design, the excellence of materials, the scrupulous care given to each detail of construction. These are the reasons why R. D. Wood Presses are the standard of excellence throughout the plastics industry.




**R. D. WOOD COMPANY**

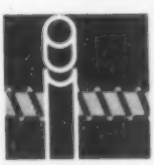
PUBLIC LEDGER BUILDING • PHILADELPHIA 5, PENNSYLVANIA



# Rotomat 1400/550

**Automatic Injection Moulding Machine «Netstal»**

**A high capacity automatic production unit with screw plasticizing and independent plunger injection for shot volumes up to 85 1/2 in³ plasticized material. The ideal solution, devoid of compromise, to master modern injection moulding technique entirely.**



**Screw Plasticizing and Plunger Injection**

NETSTAL

**Machine Factory and Foundry Ltd., Netstal/Switzerland**

# U.S.I. POLYETHYLENE NEWS

A series of advertisements for plastics and packaging executives by the makers of PETROTHENE® polyethylene resins


## Packaging Notes

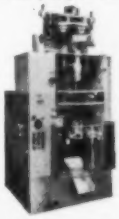
**Lamination of 300-gauge cellophane and 2-mil polyethylene** is used for low-cost, single-use package that is both a container for two aspirin tablets and a drinking cup. Heat sealing divides the package into its two compartments – upper for tablets, lower for drinking cup. It has a tear opening.

---

**Polyethylene shower caps** that double as a carrying case for damp swim suits, cosmetics and other small articles are being supplied by hotels and motels as a complimentary convenience item for guests. They can be printed with a stock or special merchandising message.

---

**A new machine** offering wide range size and high-speed automatic bag forming, filling and sealing, has recently been announced. The machine is said to be especially adapted to pouch packaging of frozen vegetables and candy products in polyethylene. It forms bags from 3" to 15" long and 2" to 8½" wide at a maximum rate of 75 per minute. Changing bag size is said to require less than 15 minutes.



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**Special laminates** of thin aluminum foil glue-bonded to paper, with a polyethylene coating on the foil or paper, have been developed by an English company to protect phonograph records from warping when shipped in hot and humid climates. Bags made of these materials are superior to polyethylene bags alone, which, although fine for temperate conditions, may be inadequate for tropical areas because of moisture vapor penetration.

The bags are produced by folding a section of laminate in half, heat sealing the sides, inserting the record and sealing the opening. The metallic or paper outside can be printed, or the moisture-protective bag inserted into a printed over-wrap polyethylene bag.

---

**Miniature polyethylene containers,** with a hinged shaker cap permitting one-hand opening and closing, are now being used for salt and pepper—at a cost equivalent to that of paper. Body, shaker cap and lid with interlocking nib are injection molded in one piece. Bottom of the 1¾" container is foil-laminated disk. Filling rate, controlled by printing speed, is 200 units per minute. The containers are sold in stores in tray packs of six for salt, three for pepper.

## Consumers Prefer Polyethylene Wrap For Dry Cleaning and Laundry

### Appeals of Flexible Containers Also Listed in Consumer Survey

In a recent survey, consumers showed a marked preference for polyethylene laundry and dry cleaning wraps; said "noiselessness", transparency, break resistance and light weight are the most appealing properties of flexible polyethylene plastic containers; and listed book covers, packaging for liquids and toothpaste tubes as the leading items "which should be made of plastic".

The survey, conducted by a market research company for U.S.I., queried a 1,300-member consumer panel to determine how they felt about polyethylene products and why. The panelists represent a cross section of consumers in seventeen major cities from coast to coast.

#### 72% for Polyethylene

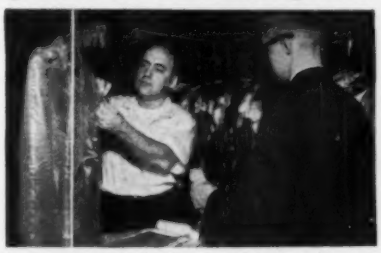
According to the survey, 72% of the panel preferred their dry cleaning and laundry wrapped in polyethylene film rather than in other wraps. High on the list of reasons for this preference to polyethylene wrap is transparency, closely followed by protection against dust and water. Other advantages cited over competitive wrapping materials are ease of storage, strength, and better appearance.

U.S.I. further learned that 70% of the participants in the survey receive their dry cleaning and laundry in polyethylene. This indicates that consumer preference for polyethylene is actually somewhat greater than the polyethylene wrapping service now being offered by cleaners and laundries.

#### Squeezable Over Rigid

In selecting the most appealing aspects of flexible polyethylene containers, 79% of the panelists mentioned the "noiselessness" of such containers as the basis for preference over the same item made of rigid plastic. Other scores in favor of polyethylene were: transparency 71%; break resistance 66%; and light weight 52%.

The choice of "noiselessness" as the leading property is significant in designing products to be used in hospitals, rest homes and private dwellings. Applications such as garbage cans and most houseware items are in this category.



Transparency, protection from dust and water, ease of storage, strength, better appearance, were reasons respondents to survey gave for preferring their cleaning and laundry packaged in polyethylene.

#### New Plastics Uses

Many of the suggestions consumers gave for items they'd like to see made of plastic can be, or already are being made of polyethylene, either alone or in combination with other materials. Examples are jelly containers, household cleaner bottles, toothpaste tubes and bread wrap. The latter use has caught on rapidly with bakers and offers, according to U.S.I. estimates, a 60 million pound potential to film producers in five years. Among other items listed were packages for liquids, milk carton coating, and thread spools. Of these, polyethylene for coating milk cartons alone represents a potential market for 110 million pounds of polyethylene.

The wide range of these survey suggestions indicates an awareness by consumers of the role of plastics in daily life and their value in improving familiar household products.

## Hospitals Fight Cross-Infection With Polyethylene-Coated Bags

Bags with a polyethylene-coated inner ply are being used in key locations in a paper and sack holder disposal system being installed in a number of hospitals in Great Britain. The system, aimed at cutting cross-infection, uses color-coded bags for disposal of soiled linen, dry refuse, kitchen waste, and soiled dressings. Filled bags are sealed before transporting to a location where they are sorted without physical contact with contents, and sent to the laundry or incinerator. Polyethylene-coated bags are used where most waste is involved, such as in operating rooms and the kitchen.

In addition to hospitals, the sack system is being used in factories, restaurants and municipalities for refuse collection and for collection of litter at public places. Advantages cited include hygienic disposal, ease of handling, flexibility of use.

U.S.I.

Series V, No. 4

# POLYETHYLENE PROCESSING TIPS

## BLOW MOLDING: SELECTING BEST POLYETHYLENE RESIN, OPTIMUM OPERATING CONDITIONS

The objective of any blow molding job is to make the best product possible most economically. To achieve this objective, resin properties and machine conditions, as well as mold cycle time, have to be considered.

The properties sought in the molded product, of course, depend on its intended application. In each case, the molder must consider the relative importance of these factors: stiffness, appearance, gloss, wall uniformity, weld line, parting line, stress crack resistance.

A product's end use determines whether it must be stiff or flexible. For most products, good appearance – high gloss, smooth surface, no flow lines – and durability are required. Uniform wall thickness, strong weld lines and parting lines with the same gauge as the walls are also desired.

Although gloss is considered a requisite for good appearance, it is listed as a separate property here because there are a number of applications in which low gloss is required. Other products may not need high stress crack resistance which may be sacrificed to some degree to improve other properties.

### Mold Cycle Time

The molder must also consider mold cycle time – a most important factor in production costs. Obviously, the shorter the cycle, the more economical the process. But here again, other prerequisites must be considered and a balance struck.

### Variables Affecting Properties

Table 1 shows the effect of an increase in resin density and melt index and extrusion and molding factors on the properties of the molded piece. Although the information listed has been obtained by extrusion-blow molding 4 oz. Boston round bottles, it generally holds true for all extrusion-blow molding processes within the ranges shown.

The blow molder can use this table to determine which variables should be adjusted to improve a given property. Also he can learn which properties are favorably or adversely affected when resin density and melt index or extrusion and molding conditions are adjusted. Table 1, therefore, is a useful guide for selecting the most suitable resin and adjusting machine conditions to obtain the desirable balance of end product properties.

**Table 1 Effect of Resin, Extrusion, and Molding Factors on Bottle Properties and Output [1]**

| Increase in these factors affects these properties → | | Resin Properties | | Extrusion Conditions | | | Molding Conditions | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Density | Melt index | Melt temperature | Annular die clearance | Extrusion rate | Mold temperature | Mold time | Blow pressure |
| Bottle properties | Stiffness | Large increase | NSE | NSE | — | Slight decrease | — | — | — |
| | Stress crack resistance | Decrease | Large decrease | — | — | — | — | — | — |
| | Gloss | Large increase | Increase at 0.915 density<br>No effect at 0.932 density | Increase | NSE | — | NSE | Increase | NSE |
| | Appearance [2] | Improvement | NSE | Slight improvement | NSE | NSE | Improvement | Improvement | Large improvement from 10 to 50 lb/sq in.<br>NSE from 50 to 80 lb/sq in. |
| | Wall uniformity | NSE | NSE | Slight decrease | Decrease | NSE | Slight decrease | NSE | |
| | Weld-line thickness (strength) | Large decrease | NSE | NSE | Large increase | NSE | NSE | NSE | Large increase from 10 to 50 lb/sq in.<br>No effect from 50 to 80 lb/sq in. |
| | Parting-line difference | NSE | No effect at low blow pressure<br>Large increase at high blow pressure | Slight increase | NSE | NSE | Increase | NSE | Large increase |
| Mold cycle time | | Large decrease | NSE | Increase | Increase | — | Large increase | Large increase | NSE |
| Range of tests limited to → | | 0.915 to 0.932 g/cu cm | 1.3 to 4.7 g/10 min | 300 to 340 °F | 54.5 to 79.5 mil | 0.2 to 0.4 in./sec | 60 to 160 °F | 12 to 24 sec | 10 to 80 lb/sq in. |

NSE – no significant effect

1) tests on 4-oz Boston round bottles

2) qualitative rating of gloss, surface smoothness, and flow lines in bottle

**Table 2**
**PETROTHENE® Resins for Blow Molding**

| | | | RATINGS | | | | | |
|---|---|---|---|---|---|---|---|---|
| PETROTHENE | Density | Melt Index | Stiffness | Melt Flow | Stress Crack Resistance | Fast Cycle Time | Overall Appearance | Bottle Application |
| 101* | 0.924 | 2.0 | 3– | 4– | 4 | 4– | 5 | up to 32 oz. |
| 102-2* | 0.924 | 2.0 | 5 | 4 | 4– | 4 | 5 | up to 32 oz. |
| 209-2* | 0.920 | 3.0 | 4 | 5 | 3 | 5 | 5 | up to 16 oz. |
| 301 | 0.916 | 1.0 | 4 | 3 | 5 | 3 | 4 | all sizes |

*Technical data sheets available.

Table shows the relative rating of each resin in each category listed. The highest numerical rating indicates the best resin in each category.

### Blow Molding Resins

Table 2 lists four PETROTHENE® resins which are suggested for blow molding. Of these, PETROTHENE 101, 102-2 and 209-2 represent the latest U.S.I. developments in the blow molding field.

U.S.I. has prepared a technical data brochure on blow molding, containing detailed information obtained in the course of an elaborate research program. Ask for a copy. Technical data on other areas of interest to blow molders not yet investigated will be released as soon as available. For information in these areas, or for assistance on any aspect of blow molding, contact the U.S.I. Sales Office nearest you.

U.S.I. INDUSTRIAL CHEMICALS CO.
Division of National Distillers and Chemical Corp.
99 Park Ave., New York 16, N. Y.
*Branches in principal cities*

# SHOWCASE FOR POLYETHYLENE QUALITY MAKES CASE FOR "QUALITY FIRST" APPROACH

***New U.S.I. exhibit at New York's Housewares Building underscores dependence of polyethylene housewares market on sound design, virgin resin, quality molding.***

Buyers and retailers entering the Housewares Building, 230 Fifth Avenue, are being attracted by a new U.S.I. exhibit designed to show them how quality housewares are made. In pictures and with samples, the exhibit traces the manufacture of top-quality polyethylene products from the synthesis of the basic resin through the design and molding stages to finished articles which give customer satisfaction . . . build repeat sales.

The aim of this educational exhibit is to protect the profits in polyethylene housewares from the stigma of low-quality products. Polyethylene housewares, well designed and carefully molded of first-quality resin, have won a deserved reputation for satisfactory service. But still some low-quality items find their way to consumers. And when *one* polyethylene product fails to give the housewife satisfaction, she sours on *all* polyethylene products — and the store that sold it reacts similarly toward the molder.

Strict adherence to standards that make for quality assures consumer acceptance of polyethylene products and profits to all of us — resin producers, molders, merchandisers.

This exhibit is just part of our program to assist housewares molders. As manufacturers of quality PETROTHENE® Polyethylene Resins, U.S.I. also assists others in the plastics industry in production of quality products. If you need assistance, our technical service engineers will be glad to recommend appropriate PETROTHENE Polyethylene Resins and processing conditions that will give best results.

**U.S.I. INDUSTRIAL CHEMICALS CO.**
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# GUIDE TO PETROTHENE POLYETHYLENE RESINS

## RESINS SUGGESTED FOR FILM EXTRUSION

| | APPLICATION | GAUGE (MIL) | ESSENTIAL PROPERTIES | SUGGESTED PETROTHENE RESINS |
|---|---|---|---|---|
| BLOWN FILM | Garment bags | 0.4 to 0.75 | Excellent draw-down, excellent clarity, high gloss, resistance to blocking, good slip. | 207, 239, 240-62 |
| | Soft-goods bags | 0.75 to 1.25 | High draw-down, high clarity, good gloss, resistance to blocking, good slip, fair toughness | 112, 206, 207 |
| | Produce bags | | | |
| | small | 1 to 1.25 | Moderate toughness, clarity, gloss, resistance to blocking, good slip | 205, 210 |
| | small or large | 1 to 2 | Very high toughness, clarity, gloss, resistance to blocking, good slip | 112 |
| | large | 1.5 to 2 | High toughness, fair clarity, gloss, resistance to blocking, good slip | 200, 205, 210 |
| | Chemical packaging bags (drum liners) | 1.5 to 3 | Very high toughness, resistance to blocking, good slip | 200, 204 |
| | Construction | 4 to 6 | Extreme toughness | 200, 301 |
| FLAT FILM, CAST & WATER QUENCHED | Soft-goods | 0.75 to 2.0 | High draw-down, clarity, gloss, resistance to blocking, good slip | 239, 112 |
| | Overwrap | 0.75 to 2.0 | Excellent clarity, gloss, resistance to blocking, high stiffness | 218 |
| | Breadwrap | 1 | Excellent clarity, gloss, stiffness | 218 |
| | Produce bags | 1 to 2 | Excellent strength, clarity, gloss, resistance to blocking, good slip | 112 |
| | Frozen vegetables | 2 to 2.5 | Extreme toughness, low temperature flexibility | 200 |
| | Skin packaging | 2 to 6 | Extreme toughness, good appearance | 205, 200 |
| AGRICULTURAL FILM | Mulch | 0.75 to 6 | Moderate toughness, high draw-down | 109-216, 201-210 |

## RESINS SUGGESTED FOR OTHER APPLICATIONS

| USE | ESSENTIAL PROPERTIES | SUGGESTED PETROTHENE RESINS |
|---|---|---|
| PAPER COATING | Good draw-down, freedom from odor, good adhesion, grease proofness, heat sealability | |
| | Best draw-down | 203-2 |
| | Highest resistance to permeability | 205-15, 239-2 |
| | Minimum "neck-in" | 201-2, 201-63, 205-15 |
| WIRE AND CABLE COATING | Excellent dielectric properties | |
| | Excellent resistance to environmental stress cracking | |
| | High frequency insulation, power cables | 300-6 |
| | Wire and cable jackets, where unusual stress crack conditions are encountered | 300-200 |
| | Primary insulation for telephone cables, general insulation where color coding is required | 300-Color Code |
| | Good resistance to environmental stress cracking | |
| | Neon sign cable (GTO-15) | 301-3 |
| | High frequency coaxial cables; primary insulation for telephone cables, multi-conductor control cables, power cables | 301-6 |
| | Weather resistant wire and cable; neutral supported secondary and service drop cable | 301-200 |
| | WD-1/TT infantry field wire | 301-202 |
| | Primary insulation for telephone cables; general insulation where color coding is required | 301-Color Code |
| | General-purpose applications | |
| | Non-critical, non-specification insulation | 302-6 |
| | TV antenna lead-in wire | 302-506, 304-516 |
| INJECTION MOLDING | Fast flow, maximum stiffness | |
| | Size: | |
| | Very large (>20 oz) | 208 |
| | Very large (>20 oz), high resistance to low-temperature brittleness and shattering | 202 |
| | Large (10 to 20 oz) | 202, 203, 207, 208 |
| | Small (6 to 10 oz) | 201, 203, 206, 207, 239 |
| | Very small (<6 oz) | 200, 204, 205, 240 |
| | Best transparency and gloss | 101, 207, 208, 209-2, 241 |
| | Best freedom from warp (low level of locked-in stresses) | 202 |
| BOTTLE BLOWING | Best appearance | 101, 102-2, 201, 206 |
| | Highest environmental stress cracking resistance | 101, 102-2, 301 |
| THERMOFORMING | Stiffness, chemical resistance, low water absorption | 205, 239 |
| | Maximum resistance to sag | 239, 301 |
| | High stiffness and thin walls | 239 |
| | Optimum toughness and great flexibility | 301 |
| | Good balance of end properties | 205 |
| PIPE EXTRUSION | NSF approved for potable water | 102-216, 109-216 |
| | Nonpotable water supplies | 550-218 |
| CALENDERING | | 102, 102-216, 109-216 |

FORM: Solid cubes approximately ⅛" on a side.
COLOR: All PETROTHENE types are available in various colors as well as natural.
PACKAGING: 50-lbs. polyethylene coated multi-wall bags, 10,000-lbs. collapsible rubber Seabdins or 100,000 lbs. Dry-Flo railroad cars.
MINIMUM ORDER: 50 lbs.
TERMS: Net 30 days.
AVAILABILITY: Warehouse stocks are maintained in most major processing areas. Your nearest U. S. I. Sales Office will give you detailed information on delivery dates.
TECHNICAL SERVICE: For technical assistance contact your nearest U. S. I. Sales Office.

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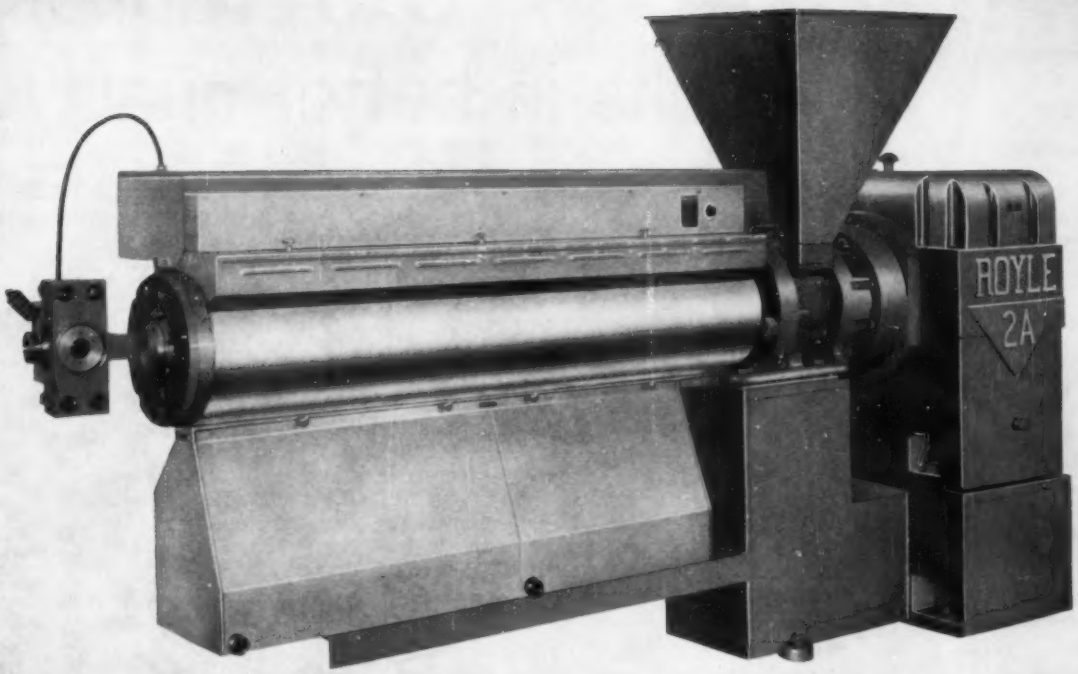
*Royle brings you*

# FASTER PRODUCTION WITH LESS WASTE




Royle Spirod Extruders are expressly designed for high speed Vinyl Extrusions. At the same time, they assure you quality controlled production not before obtainable.

The engineering advances that bring you these benefits are exclusively Royle's: high output at high stock screw speeds, due to longer length to diameter ratios; and extremely efficient evaporative cooling.

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***Royle is first in Extruder development.***

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**London, England,** James Day (Machinery) Ltd., Hyde Park 2430-0456. **Home Office,** V. M. Hovey, J. W. VanRiper, SHerwood 2-8262. **Akron, Ohio,** J. C. Clinefelter Co., BLackstone 3-9222. **Downey, Cal.,** H. M. Royal, Inc., TOpaz 1-0371. **Tokyo, Japan,** Okura Trading Company, Ltd., (56) 2130-2149.

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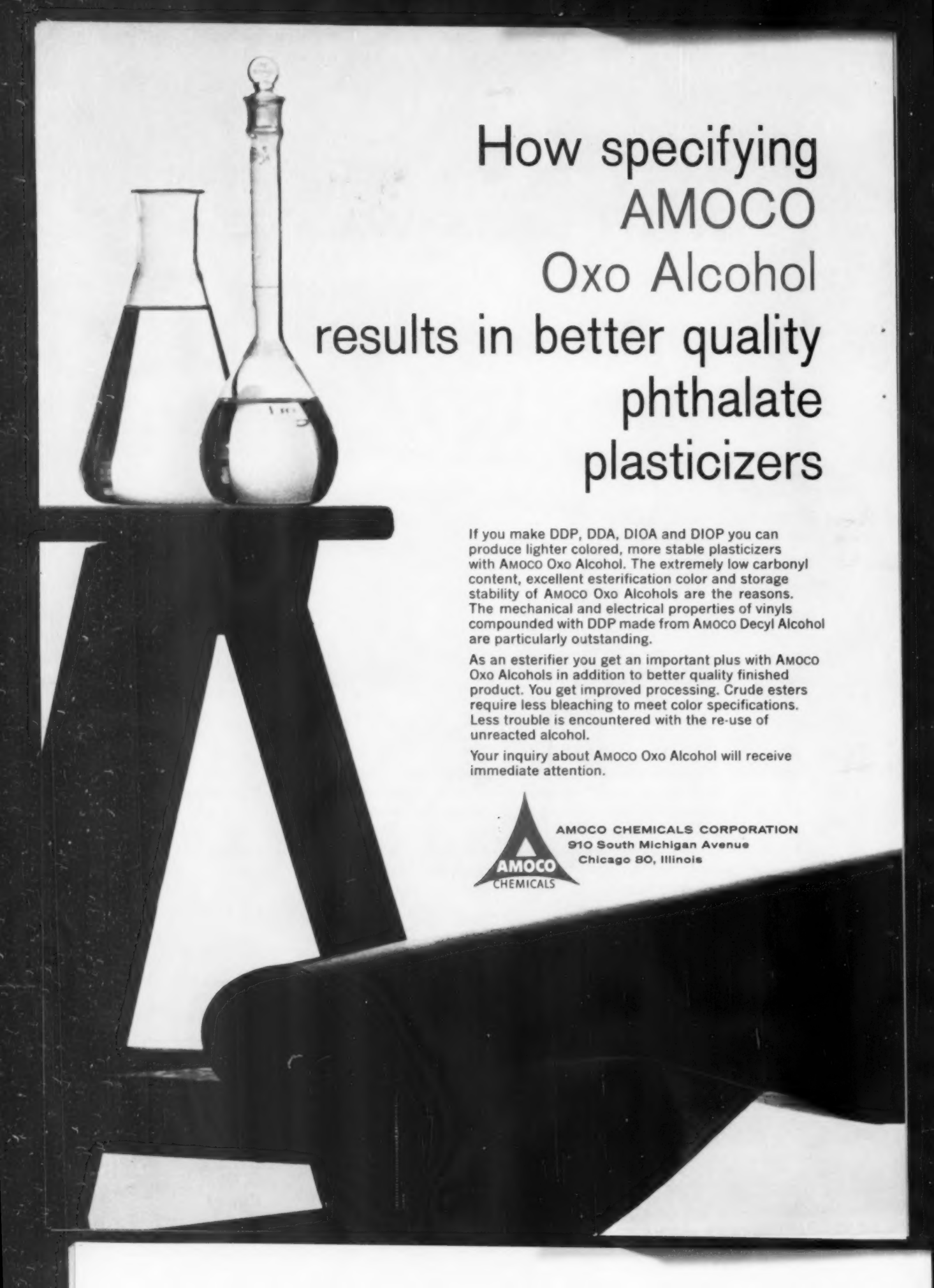

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If you make DDP, DDA, DIOA and DIOP you can produce lighter colored, more stable plasticizers with AMOCO Oxo Alcohol. The extremely low carbonyl content, excellent esterification color and storage stability of AMOCO Oxo Alcohols are the reasons. The mechanical and electrical properties of vinyls compounded with DDP made from AMOCO Decyl Alcohol are particularly outstanding.

As an esterifier you get an important plus with AMOCO Oxo Alcohols in addition to better quality finished product. You get improved processing. Crude esters require less bleaching to meet color specifications. Less trouble is encountered with the re-use of unreacted alcohol.

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AMOCO CHEMICALS

AMOCO CHEMICALS CORPORATION
910 South Michigan Avenue
Chicago 80, Illinois

July 1960, Volume 37, Number 11

MODERN PLASTICS

**OUT OF THE MISSILE AND AIRCRAFT PROGRAMS COME A NEW RANGE OF MATERIALS WITH TAILOR-MADE MUSCLES**

# PREPREGS

Photo, Kaman Aircraft Corp.

**FATIGUE LIFE OF HELICOPTER BLADES** was improved by using prepreg as part of a balanced modulus cheek plate (at center of blades). Since blades are composed of wood, aluminum, and steel, molded prepreg component provides the strength necessary to meet tension and torsion strains.

The term "prepreg," in general, has been applied to all kinds of webs—paper, cloth, mat—which have been impregnated with resins. Not to be confused with coated webs, prepregs are loaded webs with the resins thoroughly distributed in and around the web fibers.

Recently, however, this term has been more specifically used to devote those material combinations which are molding materials for high-strength and high heat-resistant applications.

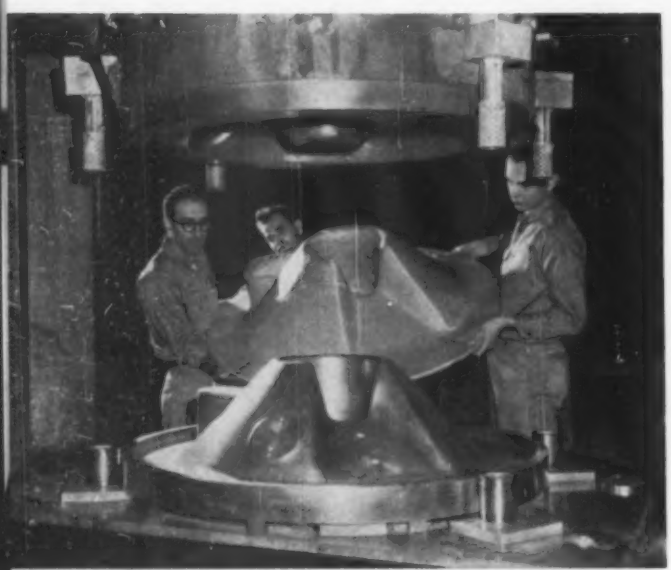
The resins used are two-stage types, assuring adequate shelf life of the raw material before molding. In these reinforced plastics applications, prepreg molding competes with wet lay-up, wherein glass or other cloth is draped on a mold and catalyzed resin poured over it. Wet lay-up is, of course, less expensive but is messy and does not provide the control of properties obtainable with prepreg.

About a dozen companies, standing midway between the makers of webs and the makers of resins on the one hand and the molders and end-users on the other, are engaged in the production of prepregs. Some weave their own glass, asbestos, and other cloths. Others purchase all their raw materials and serve to assemble them with extreme scientific accuracy. This accuracy in loading (control that assures less than 2% variation is normal) was made necessary by the early applications of prepreg in aircraft, missiles, and electronics.

Prepregs came into being because there was

no other way of engineering into raw materials properties that would be accurately reproducible in molded part after molded part, especially when the parts are large. Fully 50% of the applications of prepreg at this time are military and classified, and in cost of finished molding they range from a couple of dollars a pound to upwards of $500 per pound.

Three factors brought about the rapid development of these superior precision engineering materials. First, there was the urgent necessity for them. Second, in the military budget there was money to pay for them and for the research and development that went into them. Third, there was the youth and engineering ability of the men who went into the business. With few exceptions, they are all under 40 years of age.



**ACCESS DOORS** for re-entry vehicle are 4 ft. in diameter, matched die molded from phenolic-fibrous glass prepreg. Doors, which include small hatches and baffles when complete, allow access to instruments. Mold is shown in open position above. Below is production line. Finished product in foreground is fitted with hatches in ventilator baffles.

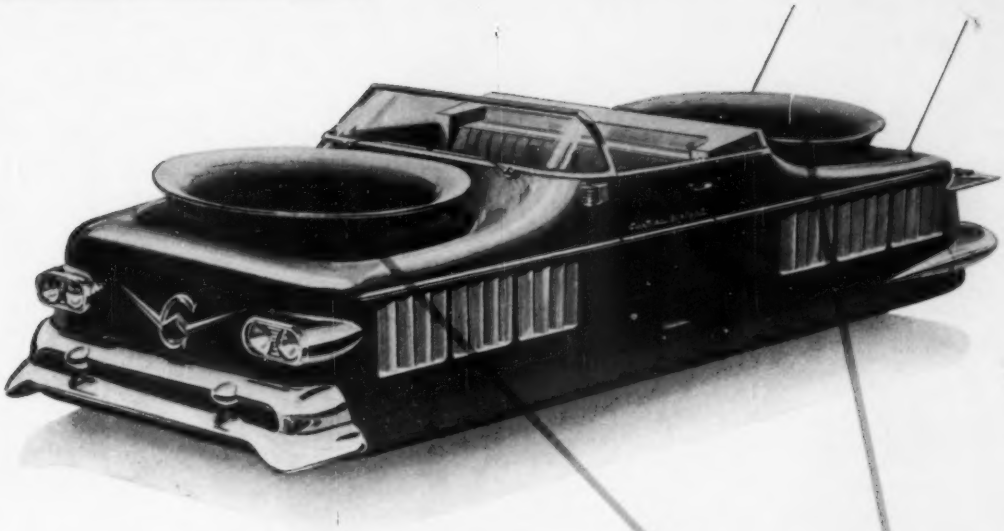
Photos, Fairchild Engine & Airplane Corp., Plastics Branch

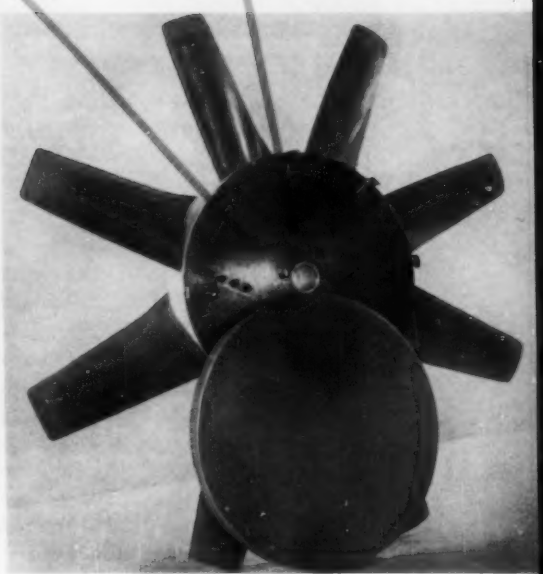
Practically every web material has found some application in prepregs. Paper, loaded with epoxies and phenolics, becomes printed circuit material and honeycomb. Asbestos, loaded with phenolics and silicones, offers superior thermal insulation and goes into rocket nozzles and the lining of combustion chambers. Glass cloth saturated with polyesters, epoxies, phenolics, or silicones becomes structural parts. Unidirectional fabrics, tapes, and rovings are used for mandrel winding to produce launching tubes and missile containers, as well as in filament winding, to make pressure vessels and pressure tanks. Nylons, as reinforcements for phenolics and epoxies, have stood up well at high temperatures. All the synthetic fibers have been used with various resins to achieve particular properties. Even cotton has been used in prepregs. It can be seen that there need be no limit to material combinations.

Since heat-resistance combined with high-strength and resistance to erosion are inherent in space vehicle and missile demands, the prepreg makers are now working with such exotic reinforcements as quartz fabric, potassium titanate, leached glass, polyolefin fabrics, graphite and carbon fabrics, even ceramic fiber. At the same time, they are working with and developing epoxy-phenolic and silicone-phenolic alloys, high-temperature and flame-resistant polyesters, thermosetting acrylics, and several types of inorganic plastics. Such new resin names as perfluoroamidine polymer and polyisoryanurate may soon become part of the language of prepregs. It is interesting to note that some of the new polymers showing up well in thermal stability and retention of strength at high temperatures in the laboratories of the military services are not high polymers but have low molecular weights.

### What are the problems?

In spite of the fact that prepreg science has advanced enormously in a very few years, there are still many problems to be solved. First, particularly in the case of polyester fabric, there are limitations on the use of catalysts and more heat and pressure must be used to mold them, than wet lay-up materials. Second, it is almost impossible at present to get transparency in the moldings or laminates, which would keep them out of some markets. Third is the matter of standards and test meth-





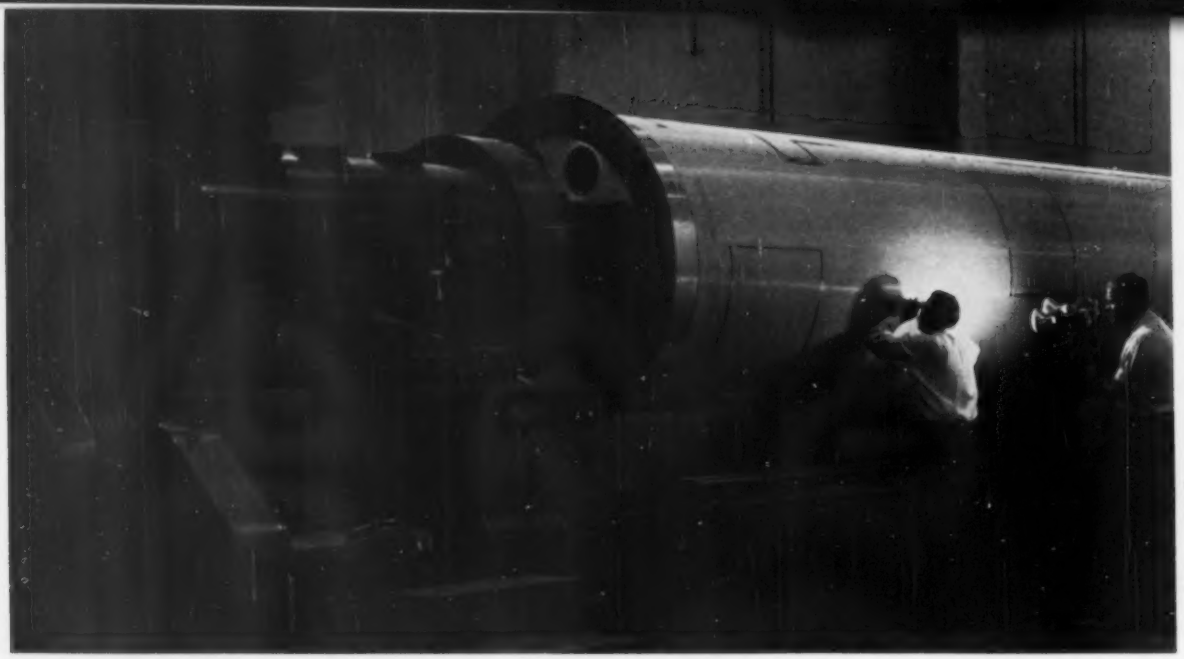
**CURTISS-WRIGHT CORP.'S** Air-Car (above) features epoxy prepreg blades in the elevating fans. Photo at near right shows the matched metal molds and the resulting pieces. At far right is the finished fan with hub cover removed. Four different types of prepreg were used in combination to produce extremely high physical strengths. Newest version of the Air-Car has 27 blades.

ods for standardization. Since these materials compete in many cases with light metals and, if the costs of prepregs are to be lowered in order to achieve consumer goods markets, certainly those that look like big-volume prospects will have to be standardized. The Prepreg Committee of the Reinforced Plastics Division of S.P.I. is currently working very hard to find agreement on test methods at raw materials level, as well as in finished laminates.

Some of the consumer markets envisioned for prepreg materials are in large-size piping, ionization chambers for water softening, ventilating and heating ducts, golf club shafts, truck and automobile body parts, home appliances, shipping containers, fans and impellers for corrosive atmosphere, and, of course, electrical and electronic components. As higher heat resistances are obtained, other new markets will suggest themselves.

One stymie to economy in prepreg molding is the cost of waste. It has been suggested that instead of supplying rolls or spools of prepreg, makers might supply small sheets in the form of squares, rectangles, circles, and triangles, which could be placed in molds with slight overlap, in order to eliminate waste and get a better flow of material to fuse in the mold.

Since so much of the business is in space vehicles, missiles and aircraft, not too many consumer product appliances have been developed. Volume applications are in fishing rods, honeycomb, and grinding wheel inserts. Pressure tanks made by filament winding



**MISSILE CONTAINER** being produced for Lockheed Aircraft is 27 ft. long with an inside diameter of 57 inches. Container wall is composed of a sandwich of prepreg skins with a honeycomb core. In this application, unidirectional material was used to achieve closer tolerances than were provided by the former metal containers.

are probably the most significant industrial application to date. Another interesting development, although small in volume yet, is in the fans or propellers for the Air-Car, made by Curtiss-Wright Corp. Standard Insulation Co. Inc. produced for this job four special epoxy prepregs, which are molded in matched metal dies, and have been tested against metal for strength and durability, and have proven most satisfactory.

In the missile area, but convertible to consumer goods use, are the access doors for re-entry vehicles, produced from Standard's phenolic prepreg by the Plastics Div. of Fairchild Engine & Airplane Corp. These are molded in matched metal dies and illustrate what can be done with prepreg in large area molding.

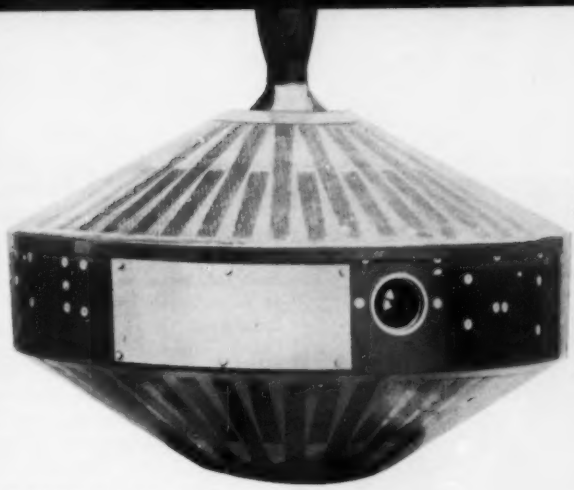
Minnesota Mining & Mfg. Co. makes its prepreg in the form of a continuous non-woven unidirectional filament sheet, which may be oriented by laying one on top of the other, at different angles, to achieve strengths in any given direction. At 3 M's Zenith Plastics Div., this material was used to make a missile container 27 ft. long with an internal diameter of 57 inches. The job was done on a huge lathe, by winding one skin on a mandrel, wrapping honeycomb core around that, and then winding the outer skin. This principle could well be translated into non-military markets.

With a view to producing highly heat-resistant reinforced plastics honeycomb, which would be the strongest and lightest structural core material produced today, Hexcel Products Inc. had Coast Mfg. & Supply Co. weave and coat, with special high-temperature phenolics, a range of very fine glass cloths. These, made into honeycomb, provide six different core materials ranging in density from 2 to 15 lb./cu. ft., in cell sizes of $\frac{3}{8}$ and $\frac{3}{16}$-in., allowing them to meet a very broad range of high performance requirements. In addition, these new honeycombs are declared to have a higher resistance to moisture than any other type—including stainless steel and aluminum. If this new Hexcel product had been available to be used in satellite Explorer I, rather than the honeycomb then available, the weight could have been reduced by $\frac{1}{4}$ lb.—and the fuel requirements to put the vehicle aloft would have been 2500 lb. less!

### Tools of prepregs, too

Another development, which holds possibilities for wide industry use, is in the manufacture of expendable Voodoo Cocoons which protect Falcon missiles on the underbodies of fighter planes. Narmco Resins and Coatings Co. worked out for McDonnell Aircraft Co. a new prepreg for low temperature cure, making it possible to mold the parts on conventional reinforced plastics tools—themselves made of prepreg. Prepreg tools offer many possibilities in plastics molding and metalworking. Readers

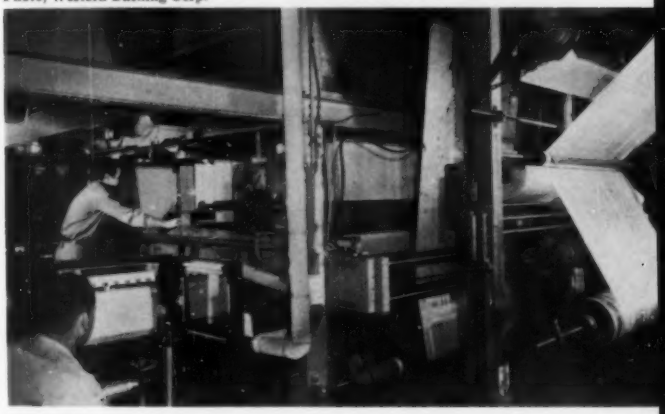
Photo, Zenith Plastics Div., Minnesota Mining & Mfg. Co.



Photo, Hexcel Products Inc.

**EXPLORER I** satellite employs prepreg honeycomb in body structure. New version of lighter-weight heat-resistant honeycomb would cut weight of satellite by ¼ lb.; would mean a rocket fuel saving of 2500 pounds.

Photo, Western Backing Corp.



**SOME IDEA** of the precision engineered into modern prepreg can be gained from this picture, which shows a traveling thermocouple recorder controlling fabric impregnation (lower center). Accurate heat transfer is checked by establishing a ratio between the total volume of heat and heat on the traveling web.

Photo, Narmco Resins & Coatings Co.

**PREPREG** is used here to produce the molds upon which other prepreg is molded in order to make cocoons for Falcon missiles.

will note the adjective "special" used throughout this article. That word reflects the current trends in the prepreg field. But some "special" materials are now becoming standard, and as standard tests and standards are developed, there will be more and more non-specials. This because of volume, should bring costs down.

But, even with the "specials," the prepregs have been able to increase production rates and cut costs, because elimination of clean-up time and the economies inherent in handling and storage can more than make up for the higher costs of prepregs, as compared to materials for wet lay-up molding.

The editors wish to thank the following men for their cooperation in the preparation of this article: Henry M. Toellner, Technical Director, West Coast Operations, Fabricon Products Inc.; H. I. Silversher, Technical Coordinator, Western Backing Corp.; H. J. Ried, General Sales Manager, Plastics Div., Standard Insulation Co., Inc.; Frank Glockner, Technical Sales, U. S. Polymeric Chemicals Inc.; J. L. Stief, Manager, Plastics Dept., Coast Mfg. & Supply Co.; W. D. Rainey, General Sales Manager, Narmco Materials Div., Narmco Industries Inc.; Gordon V. Gorecki, Reinforced Plastics Div., Minnesota Mining & Mfg. Co.; J. A. Bettes Jr., Manager, Reinforced Plastics Dept., Raybestos-Manhattan Inc.; H. Reffe, Electro-Technical Products Div., Sun Chemical Corp.; Andrew C. Marshall, Hexcel Products.—End

**The author:** James R. Turnbull, now associated with DeBell & Richardson Inc., consultants to the plastics industries the world over, was formerly General Sales Manager, Plastics Div., Monsanto Chemical Co., and later Vice President, Mitsubishi Monsanto Chemical Co. in Japan. In addition to achieving stature and high favor as a leader in marketing and management in the plastics industries, "Jim" Turnbull is an aviation enthusiast, a yachtsman, a hunter, and fisherman of international repute. He is the only Federal Game Warden and King County, Wash. Deputy Sheriff who can speak Japanese, use chopsticks, and pronounce sulfonyldibenzoic acid. Mr. Turnbull's ten predictions for the plastics industries in the 60's are the result of much deep thought applied to current trends. They merit study by all concerned.

# TEN predictions for the 60's

By James R. Turnbull

### 1. Plastics become the lowest-cost materials for mass-production

Continued declines in the selling prices of major plastic raw materials, new processing technology, and the effective use of combinations of plastics and resins to produce simplified assemblies give the synthetic materials a clear edge over ferrous and non-ferrous metals in most mass volume applications where properties are suitable. Glass retains the main architectural glazing market, but loses out in the container field.

### 2. Plastics and aluminum revolutionize housing and building construction

Pre-assembled and load-bearing panels, foam-insulated and incorporating ducts and channels for all utilities and services will be available in a range of types, permitting wide individuality in exterior and interior architectural plan and design aesthetics. Exterior wall surfaces will be prefinished aluminum. Interior wall surfaces will be available in textures (vinyl), woodgrain (polyester), or permanent, washable wallpaper effects (biaxially oriented polypropylene). Extruded plastic ducts will include an air-duct to be used for central vacuum-cleaning system.

### 3. The custom molder specializes to survive

Plastics processing becomes an accepted "in-plant" function for most manufacturing businesses, and the purchase of new molding and

processing equipment is treated as matter-of-factly as the acquisition of a new fork-lift truck. Experienced personnel become more generally available to the industry. Custom molders, unable to survive on short-run production jobs, development projects, or the "problem" applications which are farmed out, find it necessary to turn to specialization in newer materials and to the production of stock industrial components for which there is an increasing demand. In a manner of speaking, they become industrial proprietary molders and processors. Many of the older firms either sell out completely or merge with another company.

### 4. Selective catalyst systems bring in the "tailor-made" polymers

Polymer research reaches the point where a desired molecular structure can be plotted by electronic data processing methods and then reproduced in pilot plant by regulation of process equipment as well as the use of a predetermined catalyst system. Within the broad limits of organic materials, it will be possible to achieve almost any desired combination of physical and chemical properties.

### 5. A sophisticated and partially integrated market alters supplier-customer relationships

The paternal role of the raw material supplier as a source of credit, marketing aids, and technical service takes on Jekyll-Hyde overtones. Buyers bargain more intensively and are less inclined to balance service and prestige against higher-than-minimum prices. Mature raw materials become commodities fluctuating on supply and demand. Large-scale promotional efforts are limited to important new markets, or to promising new raw materials. More suppliers integrate toward the consumer.

### 6. Processing research catches up with polymer research

Wearying of trying to formulate multi-million dollar (research cost) polymers to fit processing machinery which is improved only by evolution, major plastics producers move extensively into equipment development. One result of this development: low pressure, strain-free molding of thermoplastics, permitting the use of lower-cost cast tooling.

### 7. The S.P.I. basket gets too big

The 50-ring circus of this all-encompassing trade association runs into ringmaster difficulties as the interests of the component supporters continue to diverge. The entrepreneurs in various proprietary molding side-shows are the first to set up their own tents, partially because of a wishful thought that by this means they may be able to bring order out of chaos within their particular field.

### 8. Sintered coatings and moldings become big business

The 100% solids approach to plastics coatings on metal gets a big boost from several directions. Sintering of dry polymers on hot metal parts moves into large-surface-area metal components. The use of sheet metal molds to produce large thermoplastic castings, size limited only by the size of the heating oven, opens up new applications, especially for polyolefins.

### 9. Miniaturized communications provide a major market

Dick Tracy's two-way wrist radio gets a TV tube built into it in the 1960's. Miniaturized circuitry and the extensive use of plastics makes possible the "See-a-phone" TV telephone. A portable two-way TV-radio unit is developed for military use and a simplified consumer version is in prospect. Space station relays become a factor in world-wide communications.

### 10. Hydrocarbon fuels lose out to nuclear power. Plastics and chemicals become second largest market for oil industry

A United Nations agreement to devote all nuclear energy stockpiles to peaceful use is attained. The last conventionally-powered ocean-going vessel is launched in 1966. Diesel and steam begin to disappear from the seas. Congress cancels authorization for an oil-fired TVA generating plant. G. M. introduces nuclear-powered railroad locomotive with new ultra-safe shielding system. The last dam built for hydro-power is completed in 1968. Los Angeles announces ban on all hydrocarbon fuels for household or automotive use to control the smog problem.—End

# What plastic is it?

***Multiplicity of new materials and growing numbers of entrants to the plastics field have made the problem of identification more important than ever. Fold-out chart at right gives step-by-step procedures for determining what an unknown material is***

The question posed in the headline above is one that the editors of MODERN PLASTICS are asked more and more frequently.

A manufacturer runs across a shoe horn made of plastic. He likes the feel and the color and thinks it would be just the right material for a line of letter openers he is considering producing. What plastic is it?

A foreign visitor sees a place mat that he thinks might make a good item in his country. He would like to produce it and wants to know: What plastic is it?

Here's a kitchen gadget. A housewares manufacturer thinks he has a better design but would like to use the same material. He, too, wants to know: What plastic is it?

There was a time not too long ago when such queries were easy to answer: the way a product felt, the way it sounded when tapped, the way it smelled when burned, these were often sufficient to make a pretty intelligent guess as to what it was.

But that time has passed. The introduction of new materials that resemble old ones in many superficial respects, the growth of alloys, copolymers, and blends, the increasing popularity of tailor-made formulations, all make it necessary to adopt more thorough methods in plastics identification efforts.

### How the chart is conceived

As to thermoplastic materials, the most foolproof method of definite identification is based on solubility or non-solubility of a particular material. Using a number of solvents, it then becomes a matter of successive eliminations until the final determination is made. The process is akin to the Sherlock Holmes approach to detecting: If the item is soluble in *A*, we have eliminated a whole class of resins not soluble in this solvent. Repeating the experiment with Solvent *B* will eliminate another class, and so on, until only one answer remains.

Starting at the left hand of the chart, these successive eliminations are briefly outlined—leading to the identification of the material in the circles at the end of the various lines.

Sometimes additional tests have to be performed to make the final determination. These are briefly described in Table I.

Thermosets are not readily soluble in commonly used solvents, and their identification requires somewhat different procedures, generally involving burning. These tests are summarized in Table II, which also gives additional details on thermoplastic materials.

The solvents used in these tests are commonly in use and most are inexpensive. The tests are relatively simple, although a certain amount of apparatus is required.

### How to use the chart

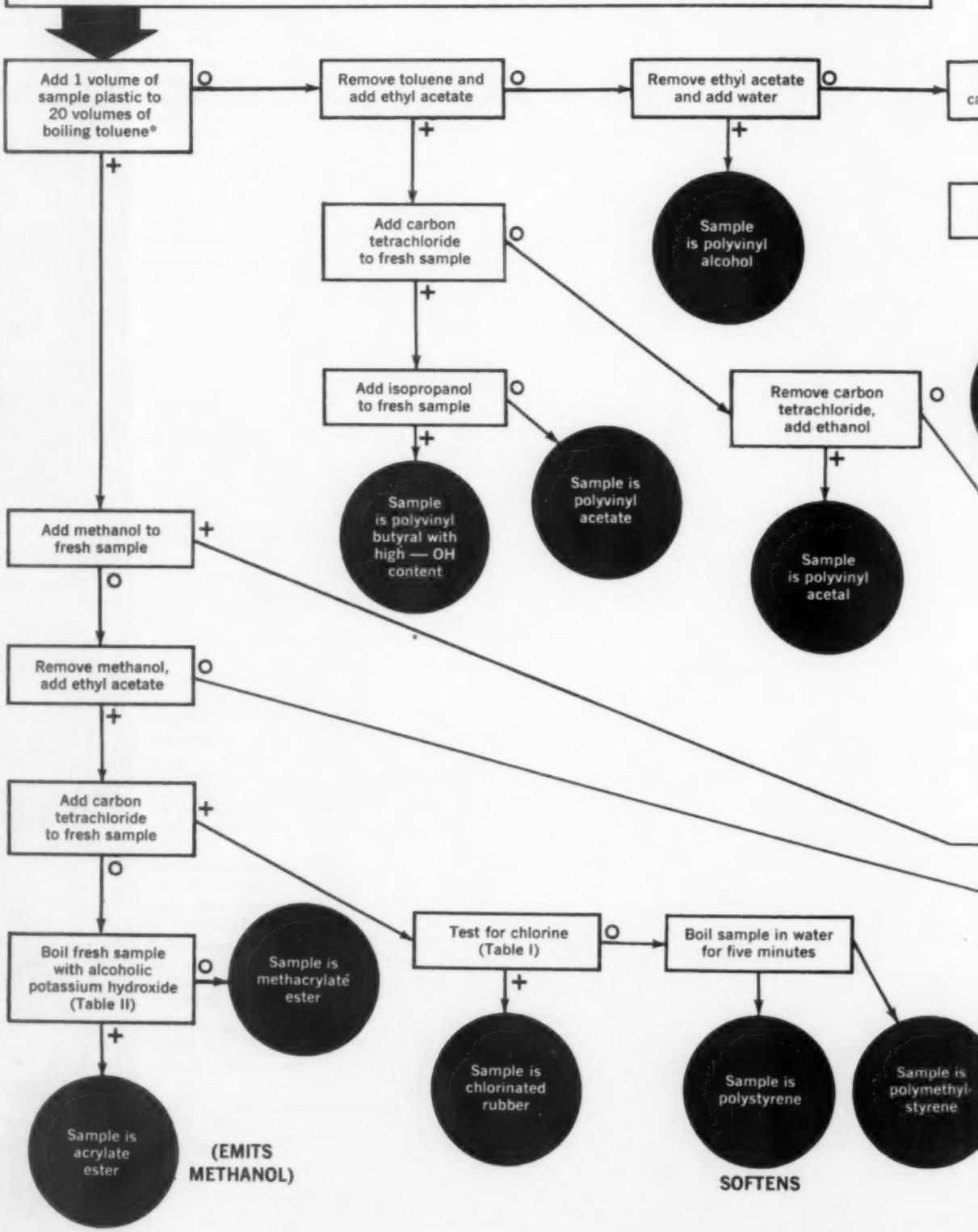
Starting at the big arrow at the left side of the chart, the sample to be identified should be placed in the solvent indicated. Then, depending on whether it is soluble or not (a plus sign indicates solubility, a zero indicates non-solubility), follow the arrow to the next step, following the instructions noted in the rectangular boxes. Continue this process until you reach one of the circles at the end of the line. This circle will contain the name of the material or materials to be identified, plus an indication of any additional tests that may be necessary.

How much solvent to use and what precautions to take are outlined in the asterisked box toward the right side of the chart.—End

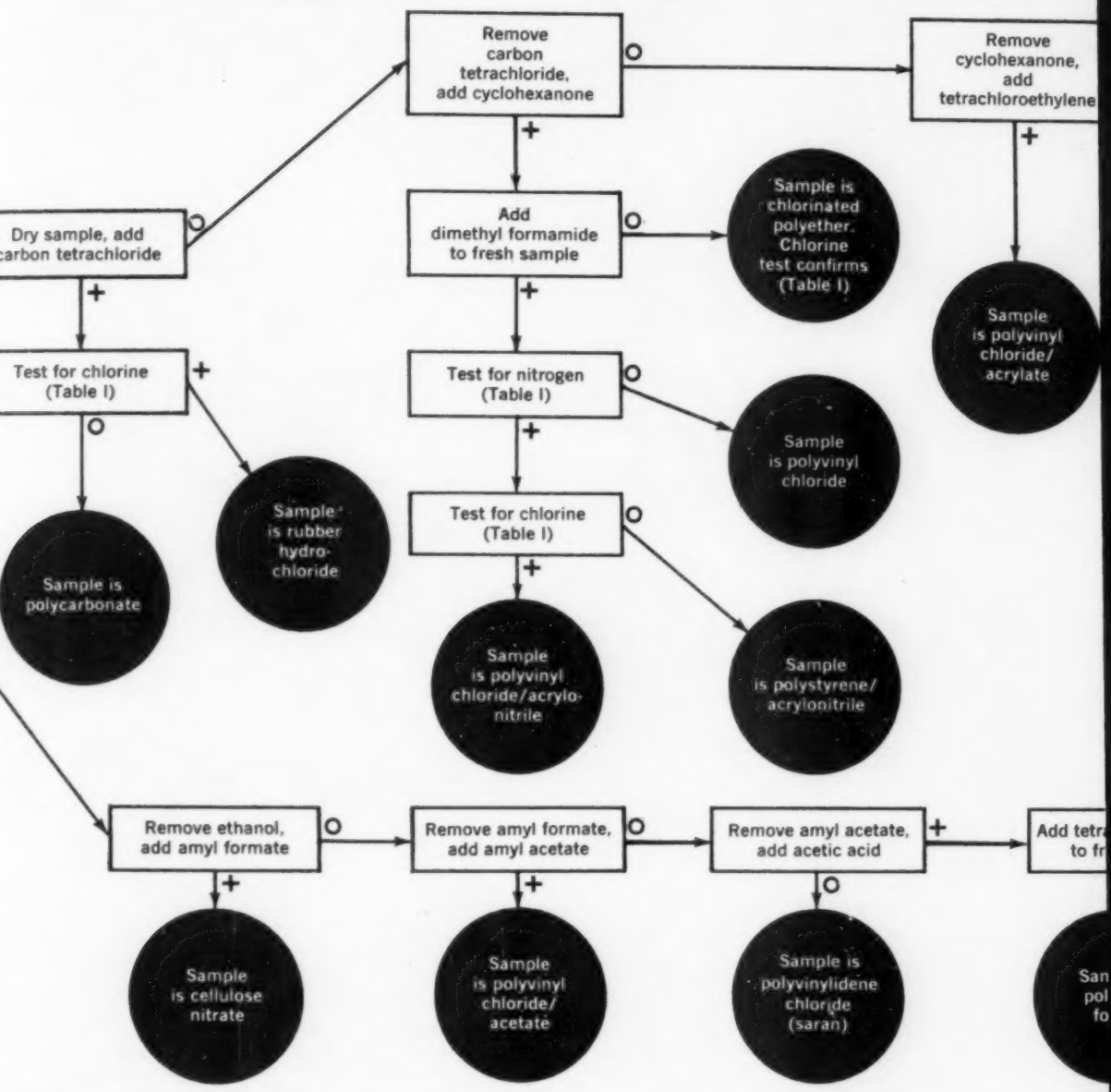
**This chart, prepared by Resin Research Laboratories Inc. for MODERN PLASTICS, is designed for wall mounting. Tear out along dotted line.**

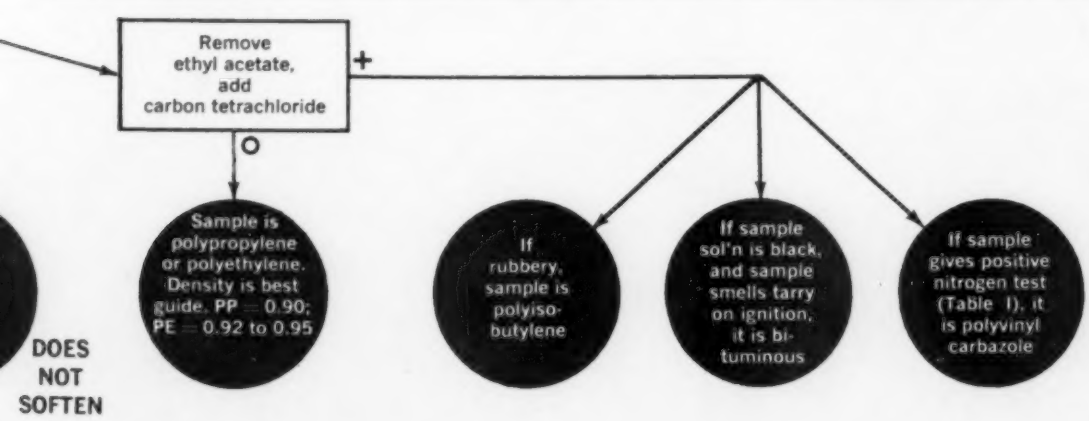
INSTRUCTIONS: Enter chart at arrow, below left, and proceed with each test according to outcome of preceding one, following arrow marked + if sample is soluble, or arrow marked O if it is insoluble. Unknown plastic will be identified in circle at end of sequence.

EXAMPLE: If sample is soluble in toluene, insoluble in methanol, soluble in ethyl acetate and carbon tetrachloride, gives negative chlorine test, softens in boiling water, it is polystyrene.

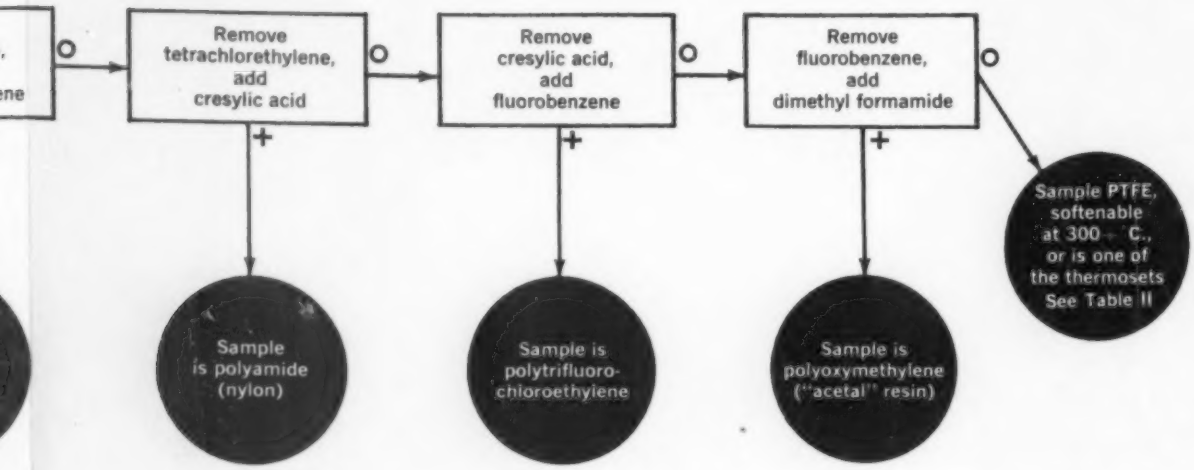

Add 1 volume of sample plastic to 20 volumes of boiling toluene*
Remove toluene and add ethyl acetate
Remove ethyl acetate and add water
Sample is polyvinyl alcohol
Add carbon tetrachloride to fresh sample
Add isopropanol to fresh sample
Sample is polyvinyl butyral with high — OH content
Sample is polyvinyl acetate
Remove carbon tetrachloride, add ethanol
Sample is polyvinyl acetal
Add methanol to fresh sample
Remove methanol, add ethyl acetate
Add carbon tetrachloride to fresh sample
Boil fresh sample with alcoholic potassium hydroxide (Table II)
Sample is methacrylate ester
Sample is acrylate ester
(EMITS METHANOL)
Test for chlorine (Table I)
Sample is chlorinated rubber
Boil sample in water for five minutes
Sample is polystyrene
Sample is polymethyl-styrene
SOFTENS

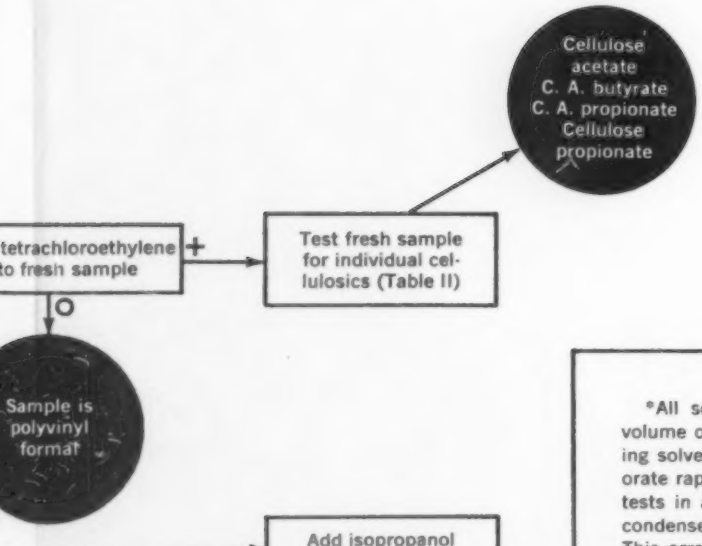
# MODERN PLASTICS POLYMER

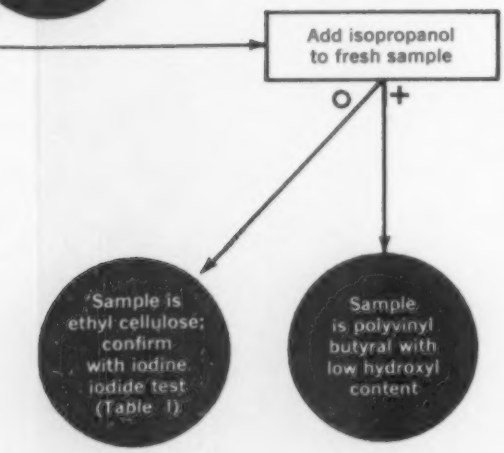

Remove carbon tetrachloride, add cyclohexanone
Remove cyclohexanone, add tetrachloroethylene
Dry sample, add carbon tetrachloride
Add dimethyl formamide to fresh sample
Sample is chlorinated polyether. Chlorine test confirms (Table I)
Sample is polyvinyl chloride/ acrylate
Test for chlorine (Table I)
Test for nitrogen (Table I)
Sample is polyvinyl chloride
Sample is rubber hydro-chloride
Sample is polycarbonate
Test for chlorine (Table I)
Sample is polyvinyl chloride/acrylo-nitrile
Sample is polystyrene/ acrylonitrile
Remove ethanol, add amyl formate
Remove amyl formate, add amyl acetate
Remove amyl acetate, add acetic acid
Add tetra to fr
Sample is cellulose nitrate
Sample is polyvinyl chloride/ acetate
Sample is polyvinylidene chloride (saran)
San pol fo


Remove ethyl acetate, add carbon tetrachloride
Sample is polypropylene or polyethylene. Density is best guide. PP = 0.90; PE = 0.92 to 0.95
If rubbery, sample is polyiso-butylene
If sample sol'n is black, and sample smells tarry on ignition, it is bi-tuminous
If sample gives positive nitrogen test (Table I), it is polyvinyl carbazole
DOES NOT SOFTEN

# R PRODUCTS IDENTIFIER


Remove tetrachlorethylene, add cresylic acid
Remove cresylic acid, add fluorobenzene
Remove fluorobenzene, add dimethyl formamide
Sample PTFE, softenable at 300° C., or is one of the thermosets See Table II
Sample is polyamide (nylon)
Sample is polytrifluoro-chloroethylene
Sample is polyoxymethylene ("acetal" resin)





Add isopropanol to fresh sample
Sample is ethyl cellulose; confirm with iodine iodide test (Table I)
Sample is polyvinyl butyral with low hydroxyl content

*All solutions are to be attempted using 1 volume of plastic sample to 20 volumes of boiling solvent. Since many of these solvents evaporate rapidly when boiled, it is wise to make the tests in a flask fitted with a water-cooled reflux condenser mounted vertically above the flask. This arrangement minimizes solvent loss, maintains the 1:20 plastic:solvent ratio.

The rate of solution — and therefore the rate of testing — is accelerated by pregrinding the sample to a fine powder.

Solvents needed for the entire scheme include: acetic acid, amyl acetate, amyl formate, carbon tetrachloride, cresylic acid, cyclohexanone, dimethyl formamide, ethanol, ethyl acetate, fluorobenzene, isopropanol, methanol, toluene (= toluol), and water. Some of these are inflammable, give off toxic fumes, are dangerously absorbed when the liquid wets the skin, or all three. Appropriate safety precautions should be taken.

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served, including th
portions thereof in a

This chart was esp
MODERN PLASTI
by Arnold Gruben
Resin Research La
Newark, N. J.

## Table I: Qual
## nitrogen, pho
## and chlorine

Decompose less t
molten metallic s
pose excess sodiu
solve in 15 ml. o

1. Test for s
filtrate with
drops of 5%
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2. Test for n
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of ferrous s
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amount of n
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3. Test for
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phosphorus
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4. Test for
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few drops o
white precip
ammonia a
light. (See

Note A. Vulcani
action of sulfu
chloride solution
tive sulfur or ch

Note B: If nitr
ent, a thiocyanat
decomposition.
by adding sever
tion to acidified
nitrogen both be
must be boiled f
nitrate solution.

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specially prepared for
ICS magazine
n and Howard H. Leiner,
Laboratories Inc.,

## litative test for sulfur, osphorus,

than 0.5 gram of plastic with sodium. After cooling, decomum by addition of alcohol. Disof water and filter.

sulfur: Acidify a portion of the h acetic acid and add several % lead acetate solution. A black of lead sulfide indicates positest. (See Note A)

nitrogen: Boil a portion of the h several drops of 5% solution sulfate and one drop of 10% loride solution. Cool and acidify chloric acid. If it is clear yellow, ative for nitrogen. A blue preicates a positive test. A small nitrogen or a poor sodium fueld only a blue or greenish-blue See Note B)

r phosphorus: Acidify filtrate acid. Add an excess of ammodate to part of filtrate. A yelalline precipitate results if is present. Warming below ns formation of precipitate.

chlorine: Take portion of filacidify with nitric acid. Add a of 4% silver nitrate solution. A pitate forms which is soluble in and discolors on exposure to Note A)

ized fibers are produced by the ric acid or concentrated zinc ns. These may produce a posihlorine reaction.

rogen and sulfur are both preste may be formed by the sodium If so, a red color is obtained al drops of ferric chloride solud extract. Should chlorine and e present, the nitric acid solution reely 5 min. before adding silver

## Table II: Specific tests[a]

**Acrylics:** Acrylate plastics are saponifiable with alcoholic potassium hydroxide and produce methyl alcohol. Methacrylate plastics do not. A 25% aqueous solution of sodium hydroxide readily saponifies an acrylic ester polymer, while the methacrylic ester will be much more resistant to saponification. A characteristic alcoholic odor from the saponification products of acrylic esters may then be detected.

**Alkyds:** Alkyds containing phthalic anhydride produce a white crystalline needle sublimate when heated strongly in a test tube. Add 3 g. of resorcinol to 1 g. of the alkyd plastic; boil for 5 min., then cool, extract residue with water and add distilled water to 50 to 100 ml. Make solution alkaline with dilute aqueous sodium hydroxide; a characteristic greenish-yellow fluorescence should appear. Note: Any phthalates (even plasticizers), can produce this characteristic greenish-yellow fluorescence of fluorescein.

**Butadiene-acrylonitrile copolymers:** Positive test for nitrogen; smells of aniline when heated.

**Butyl rubber:** Rubbery, slight aromatic smell when heated.

**Casein:** Positive tests for nitrogen, sulfur and phosphorus; smells like burned hair when heated.

**Cellulosics:** A small amount of the finely ground plastic should be boiled for some time in potassium hydroxide solution in methyl alcohol. The alcohol is evaporated and the mixture neutralized with 37% hydrochloric acid. Take portion of residue and warm with dilute sulfuric acid. If the odor of acetic acid is given off, cellulose acetate is indicated. A further odor of butyric acid indicates cellulose acetate butyrate. Odor of propionic acid indicates cellulose propionate. Another portion of the residue should be dissolved in water. Some concentrated sulfuric acid, in which a few mg. of diphenylamine have been dissolved, should be carefully poured into a test tube containing the solution of the residue. A dark blue ring at the zone of contact of the liquids indicates a nitrate and hence probably cellulose nitrate.

**Chlorosulfonated polyethylene:** Positive chlorine and sulfur tests; acrid, waxy odor upon heating.

**Epoxy plastics:** Positive nitrogen test; phenolic odor on heating.

**Ethyl cellulose:** Colorless or white cellulose derived plastics should be treated with aqueous iodine-potassium iodide solution. The plastic, freed of plasticizers by extraction with ether, is examined after immersing it in 10% iodine-potassium iodide solution, and rinsing off the excess reagent with water. Ethyl cellulose produces a pale yellow color in this test.

**Furan plastics:** A layer of aniline and glacial acetic acid (1:1) when added to an acetic acid extract of a furan plastic produces a red color (furfural). Characteristic furfural odor upon heating.

**Lignin plastics:** Never used alone, generally as reactive filler for phenolic. The phlorglucinol test for lignin: pulverize the resin, add hydrochloric acid, add one or two drops of phlorglucinol hydrochloric acid mixture (1 g. phlorglucinol in 50 ml. of concentrated hydrochloric acid) and examine under microscope. Any lignin containing material will produce a bright red color.

**Methacrylic ester:** See acrylics.

**Melamine formaldehyde and urea formaldehyde:** Positive nitrogen test; odor of formaldehyde upon heating. Boil a sample of the plastic in 1% sulfuric acid solution for ten minutes. Urea plastics will be attacked as indicated by a dulled or frosted surface. Melamine will not be attacked.

**Neoprene:** Positive sulfur and chlorine test, tarry, acrid odor upon heating.

**Phenolics:** Odor of phenol on heating. Fuse a sample with sodium hydroxide in a test tube and extract it with boiling water; acidify with sulfuric acid. The odor of phenol or cresol can usually be detected. The alkaline extract before acidification when warmed with chloroform will produce a yellow to red color if phenol is present.

**Polyester:** Infusible; odor of styrene.

**Polyoxymethylene resin ("acetal" resin; "Delrin"):** On the chart's left hand side—titled toluene, insoluble — locate the solubility test in cresylic acid. Up to this point, it was found to be insoluble in the other solvents. Delrin does dissolve in hot cresylic acid and forms a gelled solution on cooling. This solubility would place it and nylon as being soluble in cresylic acid. Nylon does not form the same type of gel solution and seems to be much more readily soluble in cresylic acid. The further distinction between nylon and Delrin lies in the positive nitrogen test obtained in the case of nylon plastic.

**Polyvinyl acetal:** The verification of aldehydes in acetal plastics:[b] a reagent of 0.10 g. of azobenzene phenyl hydrazine sulfonic acid in 100 ml. of distilled water is prepared. A small piece of plastic is added to 1 ml. of this reagent plus 0.4 ml. concentrated sulfuric acid and heated on a steam bath for 2 to 3 min. and cooled. Three drops of methyl alcohol are then added and then a layer of chloroform. Add 0.5 ml. concentrated hydrochloric acid and shake. A positive test for aldehyde is confirmed by a red colored chloroform layer.

**Rubber — natural, hard:** Characteristic odor of burned rubber on heating.

**Silicone plastics:** Hard. Burn plastic to ash under strong heating in suitable apparatus. Add hydrofluoric acid to ash. This should solubilize the silicone dioxide if present. Evaporation of this solution should leave no residue. This is a confirmatory test for silicone plastics and rubbers.

**Styrene-butadiene:** Rubbery, test for sulfur, odor of styrene on heating.

**Urea-formaldehyde:** Test for nitrogen, odor of formaldehyde on heating.

**Vulcanized fiber:** When held directly in a flame, vulcanized-fiber plastics are almost nonflammable; they burn slowly while held there, giving off the odor of burning paper.

---

[a] Chemical tests such as those indicated for the acrylic plastics above should be performed with ten to twenty volumes of the reagent solution, unless otherwise noted.

[b] "Delrin" "acetal" resin, whose structural formula is

$$\left[\begin{array}{c} H \\ -O-C- \\ H \end{array}\right]_n$$

has no aldehyde groups and will not respond to this test.

Photo, General Foam Plastics Corp.

# BURGEONING BEAD BOARD BUSINESS

***Polystyrene foam slab stock is expected to reach annual sales in excess of 350 million bd. ft. by 1964 (about 25 million lb.). Here are the markets, the materials, the machines— and what it takes to get into this business***

The best indication that the polystyrene foam board industry is booming is that sales growth is always talked about in units of 50 million board feet (a bd. ft. measures 1 ft. by 1 ft. by 1 inch). In 1958, sales were around 150 million bd. ft.; 1959 sales were up 50 million bd ft.; current sales are at a rate of 250 million bd. ft.—again an increase of 50 million. In 1964, actual sales are expected to reach 350 million bd. ft., but the potential is more than 1 billion!

These figures represent both types of polystyrene foam board: the expanded (Styrofoam), made only by The Dow Chemical Co. in five plants covering the main geographical divisions of the country, with a combined capacity estimated at between 150 and 200 million bd. ft.; and the bead board or expandable foam made from raw material supplied by Koppers Co. Inc., Pittsburgh, Pa.; United Cork Companies, Kearny, N. J.; and Dow, and produced by about 20 molders with capacities ranging from about 5 to 50 million bd. ft. annually, and a combined capacity of between 125 and 150 million bd. feet.

Broadly speaking, both types of foam board are suitable for the major applications, and it appears impossible to divide market figures into Styrofoam and bead board. The important difference between the two materials is that the Dow process is exclusive to that company, but anybody is free to produce board from expandable beads. Styrofoam is supplied in densities from 1.75 to 4.5 lb./cu. ft.; bead board ranges from 1.0 to 4.0 lb./cu. ft. in commercial formulations. Bead board is more pliant than Styrofoam. And since the compressive strength

**SHINGLE APPLICATION** is faster when polystyrene foam is used as backer. Nailed-on strips of foam, ⅛ in. thick, provide swell and distortion resistance; they are water-, rot-, and fungusproof, and are effective shock absorbers when used under shingles.

Photo, The Gilman Brothers Co.

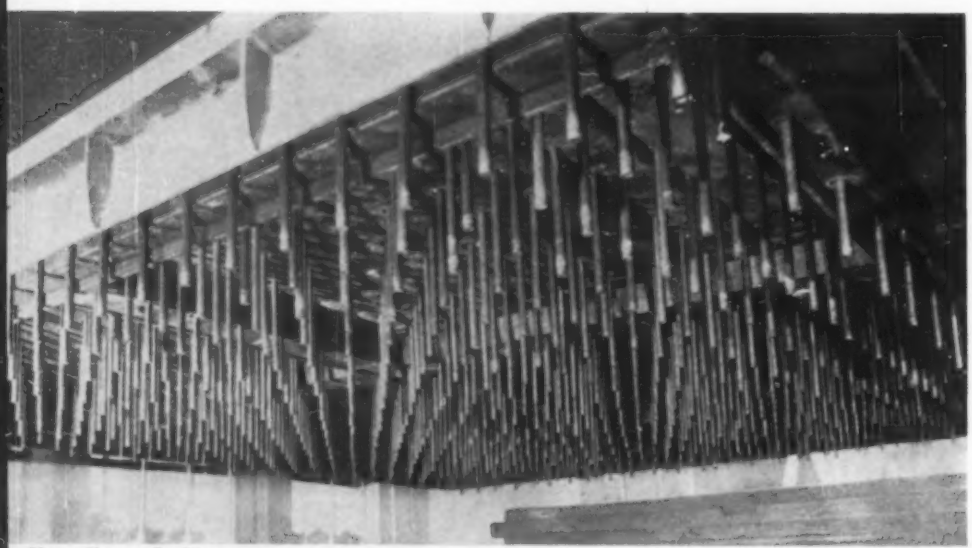
**TABLE I: Percentage of sales by end use**

| Application | 1958 % | 1964 % (minimum) | 1964 % (maximum) |
|---|---|---|---|
| Board feet in millions | 150 | 350 | 1000 |
| Low temperature insulation | 50 | 50 | 32 |
| Refrigerated transportation | 15 | 5 | 9 |
| Flotation | 5 | 6 | 2 |
| Building insulation | 15 | 30 | 52 |
| Miscellaneous | 15 | 9 | 5 |

depends on density, the bead board can be formulated to meet specific requirements. Dow supplies its expanded foam in logs, planks, and boards; beads can be custom-molded, giving more flexibility in dimensions. The K factor, or insulating efficiency of bead board, is more than 10% better than Styrofoam.

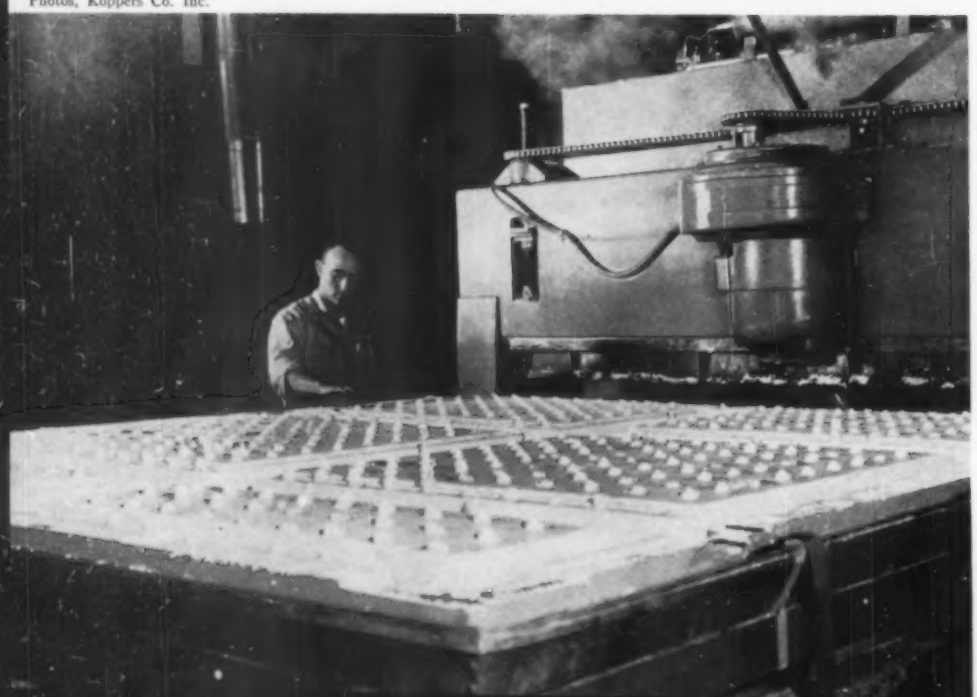
**How bead boards are made**

The choice of materials—regular grade or self-extinguishing—the method of pre-expansion of beads to the desired density, and the technique of molding by steam chest, are the same for producing boards as for more com-



**OVER 640** steam probes move down into 44½ cu. ft. of polystyrene beads when the molding machine goes into operation to make insulating door liner for refrigerated railroad cars. For picture of finished board, see below.

Photos, Koppers Co. Inc.



**FINISHED FOAM,** which was expanded in a previously vacuum-formed shell of Cycolac ABS, weighs 89 lb., measures 9 ft. 3 in. by 8 ft. 6 in., is 8 5/16 in. thick. Completed door liner made by Landis Industrial Co. for Pacific Fruit Express Co., saves 400 to 500 lb. in weight of car door. Raised pattern on foam is caused by steam probes, which fuse beads to fill cavities as probes are extracted.

plex shapes described in last month's article ("Boom ahead for styrene foam," MPl, June 1960, p. 87).

Steam chest molding machines built by Dura-Tech Corp., Boca Raton, Fla., cost about $7000 for the smallest machine, capable of molding a block measuring 16 by 24 in. by 8 ft.; and about $15,000 for one capable of molding blocks measuring 16 by 49 in. by 16 ft. 4 inches. Common cycle for this type of machine is as follows: the mold is pre-heated and then charged from the open top side, completely filling it with pre-expanded beads. The mold cavity is locked tight and then shot with steam at a pressure of approximately 13 p.s.i. The mold is then cooled externally with water jets. After cooling, the front chest is retracted, permitting the block and mold cavity to move out onto a conveyor where the block is removed and the cycle repeated. The overall cycle time depends on the size of the mold and the thickness of the block. For a block machine 16 by 48 in. by 8 ft., the cycle time is about four to five blocks per hour.

For the expansion of beads in large, thick sections, or between skins, such as large buoyancy members, insulated wall sections, and molding-in-place of sandwich panels, probe molding is frequently used. This system utilizes perforated metal tubes sealed at one end, with the other end attached to a flexible hose or multiple probe header to introduce steam into a mold cavity. The probes are inserted into the charged mold cavity through holes in its walls. Steam is forced into these tubes under pressure and is distributed among the beads through small perforations. Immediately after fusion has been accomplished, but before the steam is turned off, the probes are quickly withdrawn from the mold, and the pressure of the expanding beads closes up the tubular holes left by the probes. Some molders feel that this method has the disadvantage that the condensation cannot escape entirely and remains locked in the foam; and also that steam distribution is not even. The probes are made from tubes and are not available through regular equipment suppliers. Cost data are actually too divergent at the present time to be meaningful.

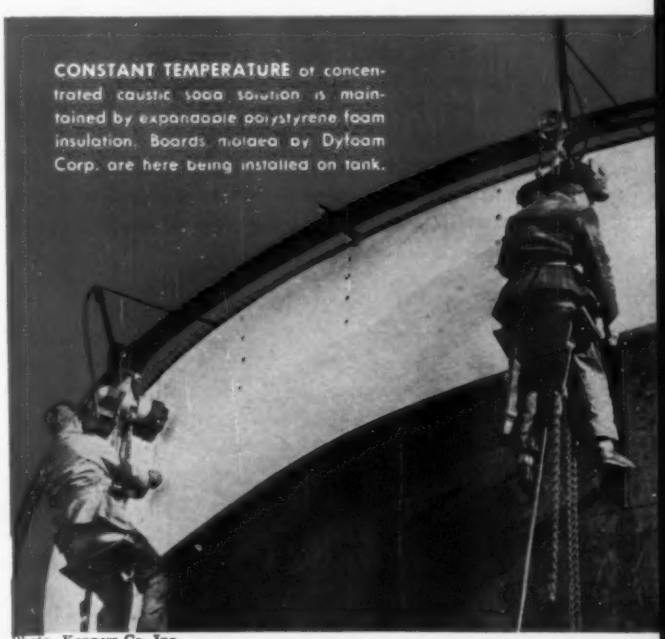
Another method of producing boards from beads is the continuous molding of the foam in sheets and slabs in widths of 2 ft., and thicknesses up to 13 inches. The advantages of this process—currently used by Dyfoam Corp., New Castle, Pa.—are said to be the high rate of production and relatively low labor cost. However, quality control is more critical and high yield is more difficult to maintain. In conventional block molding, the yield is about 10 bd. ft. per pound of beads, at 1 lb./cu. ft. density.

Photo, The Gilman Brothers Co.

**PERMANENT INSULATION** and effective vapor barrier is quickly achieved by foam plaster base. Portland cement is used to bond the foam to the masonry, then the plaster is applied.

### Fabricating the blocks

The finished blocks can be cut into sheets by saws or hot wire cutting equipment. Saw cutting produces an open type surface, which is usually desirable for plaster base—one of the building insulation uses. The hot wire fuses



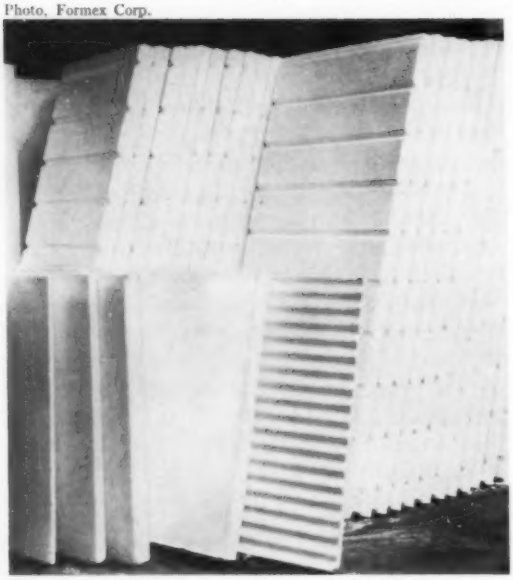
**CONSTANT TEMPERATURE** of concentrated caustic soda solution is maintained by expandable polystyrene foam insulation. Boards molded by Dyfoam Corp. are here being installed on tank.

Photo, Koppers Co. Inc.

Photo, The Dow Chemical Co.

**FLOTATION CHAMBERS** of aluminum boats are filled with easily installed foam blocks to provide puncture-proof buoyancy.

Photo, Formex Corp.



**CORRUGATIONS** and other contours can be molded into block to simplify installation for the aluminum sidings and similar applications.

the surface and yields a relatively hard surface film. Dura-Tech has developed a line of hot wire cutting machines designed to cut blocks of any size into any given thickness, any number of pieces, and trim to any board width simultaneously on one pass through a multiple wire cutter. The cost of this type of equipment ranges from $2800 for a simple machine to about $5500 for one equipped with a conveyor belt by which the block is fed continuously through the harp which can have up to 78 wires. Plastifoam Corp., Rockville, Conn., has installed an imported wire cutting machine especially for shaping sheets as backing for aluminum sidings, with 160 wires and a cutting speed of 4 ft./min., capable of cutting blocks into ⅛-in.-thick sheets.

### Sizes and prices

Molders appear to have different ideas about the most suitable dimensions of the blocks. Dura-Tech, for example, has made blocks up to 16½ ft. long, whereas many molders make blocks only 8 or 12 ft. long. Widths vary from 24 to 48 in., and thicknesses from 1 to 20 inches. Because of these different dimensions, blocks range from 16 to 150 cu. feet. Granada Plastics Co., Santa Ana, Calif., is limiting the size of its blocks to 1 by 4 by 8 ft. for the time being; Formex Corp., Elkhart, Ind., makes blocks in the same widths and lengths, but varies the thickness from 1 to 6 in., including fractional dimensions. In addition, the company makes densities from 1 to 4 lb./cu. ft. and feels that even 10,000 bd. ft. can be economically custom molded to exact dimensions. The Gilman Brothers Co., Gilman, Conn., molds 1200 bd. ft. with each shot, or enough insulation for the average house in two shots.

An important new large block molding application is a door liner for cars of Pacific Fruit Express Co., where the foam core is expanded in a previously vacuum-formed shell of Cycolac ABS, supplied by Marbon Chemical Div., Borg-Warner Corp. The inside of the doors measures 9 ft. 3 in. by 8 ft. 6 in. by 8 5/16 in. thick, and the 89-lb. moldings of Koppers' Dylite polystyrene bead forms a tight, moisture-proof non-sagging insulation, which results in savings of approximately 400 to 500 lb. in car door weight.

In the process developed by Robert L. Landis and used by Landis Industrial Co., Santa Clara, Calif., the pre-expanded beads are fed into the Cycolac liner which has been sprayed with a special adhesive developed by Minnesota Mining & Mfg. Co. The foam is produced by 645 steam probes which are injected into the loose beads (see photos on p. 98). During this process, the dried adhesive inside the liner is reactivated

by the steam, welding the foam to the ABS shell. The first of 1025 railroad cars in which this insulating door liner is used have now started rolling off the assembly lines.

In addition to standard polystyrene board, some companies produce pre-scored board to snap easily and cleanly along its length, especially to reduce installation time for perimeter, foundation, and cavity wall construction. In some cases, board laminated with kraft paper or other protective covering is supplied for uses as insulation under build-up roofs.

The average price per board foot is 8½¢ for the regular grade and 9¢ for the self-extinguishing material in carload lots—about 30,000 bd. feet. Freight rates per pound are high because of the light weight of the material. A full railroad car of expanded polystyrene will generally be around 3000 to 4000 lb., but railroads consider 10,000 lb. the minimum weight to qualify for carload rates. The distance a producer can profitably ship expanded polystyrene board and the amount of freight cost which must be absorbed through equalization on any particular shipment will affect the profit picture. Some people in the industry feel that only regional markets within a radius of about 500 miles can be supplied profitably, but opinion varies on this point. Surveys show that markets for polystyrene foam board are almost equally divided between the main geographical areas: Northeast, Midwest, South and Southeast, and Pacific and Mountain states.

**What are the volume markets?**

Insulation of various types has accounted for more than 80% of the total market for polystyrene foam board, and market forecasts indicate that this percentage will be fairly constant even when total sales reach the large volume that was indicated at the beginning of this article.

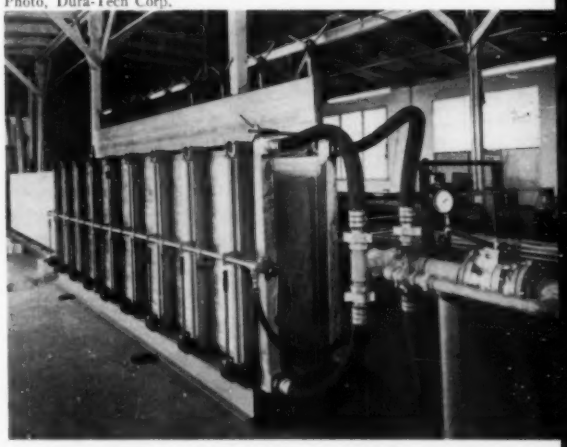
Low temperature insulation consists mainly of cold storage and process space insulation in the meat packaging, poultry, fishing products, ice cream, cheese manufacturing, candy manufacturing, baking, beverage, frozen fruits and other food specialties industries. In addition to the processing industries, refrigerated warehouses owned by chain stores, trucking firms, distributors, and other companies are big users of insulating materials. In these applications, permanence of physical and thermal characteristics, sustained moisture and vapor resistance, initial thermal efficiency, fire resistance, vermin resistance, and structural **(To page 173)**

## Typical bead board molding machines

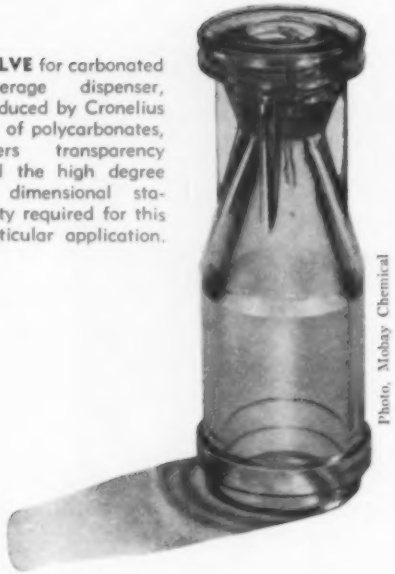
Photo, Metall-Chemie G.m.b.H.

**COMBINED AIR** and mechanical filling of closed mold through unit, top center, is special feature of this block molder, shown here in open position. Block is ejected vertically and can be removed by operator or conveyor. Pipes in foreground are for water, steam, and drainage. Panel behind operator controls fully automatic cycle. Unit costs approximately $15,000. ←

Photo, Dura-Tech Corp.



→ **OPEN POSITION OF MOLD** shows horizontal retraction of finished block at end of molding cycle. In operation, panel at top is clamped down, and steam is fed through hose lines at front. Blocks 16½ ft. long have been made on this type of unit.



**VALVE** for carbonated beverage dispenser, produced by Cronelius Co. of polycarbonates, offers transparency and the high degree of dimensional stability required for this particular application.

Photo, Mobay Chemical

Photo, General Electric

**IMPELLERS,** molded of polycarbonate in two halves, are solvent cemented for permanent bond, withstand abrasive wear better than bronze, serve at 280° F. without distorting.

# POLYCARBONATES

It's an amazing fact, but even before there has been any announcement of domestic commercial polycarbonate production, there are already—according to one resin supplier—over 200 commercial applications for this material. While total consumption is not overwhelming (only several hundred thousand pounds will be used in 1960), the range of industries into which the material has already gone is significant: electrical, machine housings, cameras, electronics, processing, automotive, appliances, instrumentation, and aircraft. In addition, hundreds of other applications in still other fields are under evaluation.

And volume will certainly not remain at this level for long. True, no one expects polycarbonates to grow to the poundages of such low-priced thermoplastics as polyethylene, PVC, or polystyrene. Polycarbonates are engineering materials with an outstanding combination of properties that far exceeds the requirements of most consumer products. But estimates place annual consumption by 1965 at a minimum of 20 million lb. per year. How much beyond this minimum the industry will grow will depend greatly on the price picture.

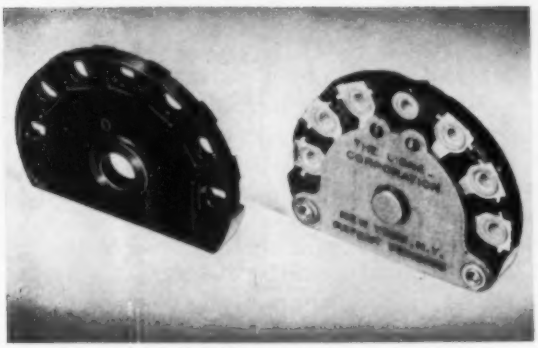
Development quantity prices were $2.50/pound. Commercial molding-grade resins were expected to go at about $1.75, but by the time this is printed the price may be $1.50, and some blue-sky crystal gazers can even visualize a 60¢/lb. tag. But that's the lowest figure anyone would venture—and it seems many years in the future.

At that last figure, and on a price-per-cu.-in. basis, polycarbonates will cost about half as much as brass, about three-fifths as much as high-impact phenolics and nylon, and somewhat less than polyester and zinc; if Delrin acetal resin ever goes down to 60¢/lb., it would be at about the same level as polycarbonates at 75 cents. On a cost-per-cu.-in. basis, polycarbonates compare to their closest thermoplastics competitors as follows: Delrin @ 0.80 now = 0.0411 $/cu. in. Carbonate @ 1.00 now = 0.0433 $/cu. in. Nylon @ 0.98 now = 0.0403 $/cu. in. But the price comparisons are particularly significant in respect to the metals with which they also compete.

First, it's these plastics that polycarbonates are expected to compete with most strongly; second, the price figures, while they already look attractive, refer only to material cost. Since metals generally involve many machining operations unnecessary with molded resin, the price advantage in favor of the latter is further heightened when considering the finished product.

### Who's in it?

Until very recently, the only domestic producer of the resin was the Chemical Materials Dept. of General Electric Co., Pittsfield, Mass. The company has been supplying semi-works quantities to molders for several years, and a large portion of the 200 applications mentioned above were developed from these supplies. Now it expects to come on stream with a full-scale commercial facility at Mt. Vernon, Ind., during the third quarter of 1960. No capacity figures are available, but industry talk places it in the vicinity of 10 million lb. per year.



**REPLACES THERMOSET.** Polycarbonates are first thermoplastic used by Lionel Corp. to mold rotor and stator telephone headset switch.

**TRANSPARENT** gage on coffee maker, fabricated from extruded polycarbonate, permits determination of coffee level without need to lift the lid.

# are starting to move

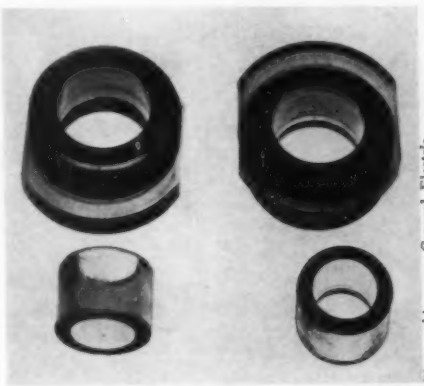
***Unique combination of properties has resulted in phenomenal acceptance of new resin in many fields—despite high per pound cost. What is the market and price picture going to be in 1965?***

Molding, extrusion, and casting grades will be produced, all under the tradename Lexan.

The second company in the field is Mobay Chemical Co., Pittsburgh, Pa., which through an arrangement with Farbenfabriken Bayer A. G., Leverkusen, Germany, has been supplying processors with imported resin for almost a year now. The firm has been building a polycarbonate producing facility at its New Martinsville, W. Va., complex, and this plant has just announced full commercial production. First resins coming from the facility are molding grades and solvent-casting grades. Capacity has not been disclosed but is also thought to be about 10 million lbs.; Mobay's designation for its resins will be Merlon.

These are the only two material makers whose hat is officially in the polycarbonate resin ring. But there are persistent rumors that Union Carbide Plastics Co. may be in the race, too, possibly with copolymer-type resin with somewhat the same properties. The company is not talking. But all who have seen its "phenoxy" resin claim that it looks very much like polycarbonate material.

A fourth company rumored to have made exploratory moves into the polycarbonate field is Columbia Southern Chemical. But there are no current indications of any near-term commercial production.



Photos this page, General Electric

**REPLACES NYLON.** Emergency truck brake bushing, molded by Automatic Plastic Molding Co., Berkeley, Calif., for MGM Brakes Inc., Cloverdale, Calif., solves problem of wear and entry of water and debris into brake cylinder.

One step away from basic production, there are now several warehouse distributors who have mill shapes available—rod, plate, disks, mechanical tubing, and film and sheeting.

And Fiberfil Inc. has come out with a glass-reinforced polycarbonate (less mold skrinkage,

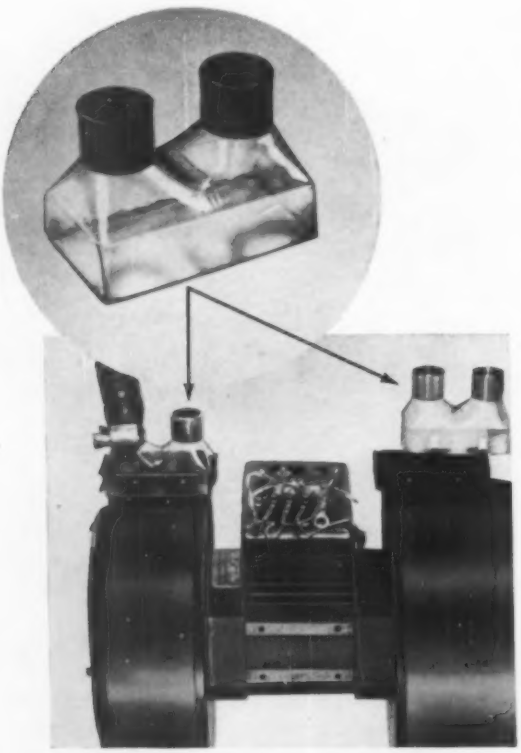
higher tensile, greatly reduced elongation, and better impact) that has already found application in wiring bases. Tradenamed Carbafil G-50, the material sells at $1.55 when ordered in 20,000-lb. quantities.

**What are the properties?**

The reason that polycarbonates have already gone into 200 commercial applications is found in the impressive combination of properties offered by the material. While other resins may match one or the other, there is probably none that can match them all.

Take impact strength for example. Polycarbonates are as strong and stronger than the highest impact ABS materials, and in the same range as glass-fiber-reinforced thermosets. But polycarbonates are transparent; can be injection molded, extruded, blown, formed, and cast; have a heat distortion temperature of 280 to 290° F.; and low water absorption (0.3%, 24 hr. ⅛-in. specimen).

One new application that takes advantage of these properties is a transparent cup gage in General Electric's Peek-A-Brew coffee maker. The gage is based on Lexan tubing extruded by Polymer Corp., Reading, Pa., and Anchor Plastics, Long Island City, N. Y., and permits the user to tell how much coffee is left in the pot without lifting the lid.



**REPLACES BRASS.** Vacuum formed from 40-mil polycarbonate sheet, transition coupler eliminates all machining operations formerly necessary with brass. Inset shows component in close-up.

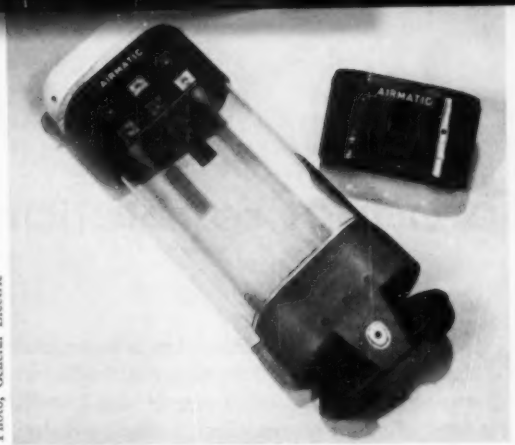
In another application, involving toughness, flame resistance (the material is self-extinguishing), and the ability to withstand temperature cycling from —130 to 130° F., 40-mil Lexan sheet was vacuum formed on wooden dies to produce transition couplings in a blower that furnishes cooling to hot spots in delicate radar components. In this application, polycarbonates replaced brass at significant cost savings. These savings were the direct outgrowth of the fact that no machining operations (necessary with brass) were required. The units were formed by Tracking & Acquisition Radar Equipment Section, GE.

Still another example are impellers molded of polycarbonates that replace bronze in a line of self-priming convertible jet pumps manufactured by Sta-Rite Products Inc., Delavan, Wis. Strength coupled with the ability to withstand temperatures of 280° F. without distorting enabled the resin to outperform bronze. Also, the polycarbonate impellers withstood abrasive wear better than the bronze variety, and did not swell, soften, or change dimension and shape in water or dilute acids.

Or take the electrical properties of polycarbonates: power factor and dielectric constant are low (0.0009 and 3.17, respectively, at 60 cycles and 23° C.), and volume resistivity is high over a broad range of temperature and humidity conditions. These properties are combined with transparency, impact strength, flame resistance, and easy processability.

Typical of the applications making full use of this combination of properties is a rotor and stator for a telephone headset switch manufactured by the Lionel Corp. Here, polycarbonates replaced phenolic and are in fact the first thermoplastic used by the company in molding such parts. Design life of the part is 100,000 cycles.

Other applications are depicted in the accompanying photographs, together with the reasons why polycarbonates were the material specified. They all point up the fact that despite the relatively high material cost, end users find worthwhile economies through a full utilization of the resin's properties. For exact




Photo, General Electric

**WAR HEADS,** molded by Berkeley Engineering & Mfg. Co., Berkeley Heights, N. J., serve as control centers for direct contact pneumatic tube carriers manufactured by Airmatic Systems Corp., Saddle Brook, N. J. Design permits the placement of all of the control elements in the head, as contrasted with conventional systems in which the station designations are set by means of a sliding contact along the length of the carrier.

Photo, Mobay Chemical

**TUNER SPACER PARTS,** molded for General Instrument by Darrill Products of polycarbonate resin, take advantage of the satisfactory electrical properties of the material.

values of the properties, readers can refer to the Plastics Properties Chart of the *Modern Plastics Encyclopedia Issue for 1960.*

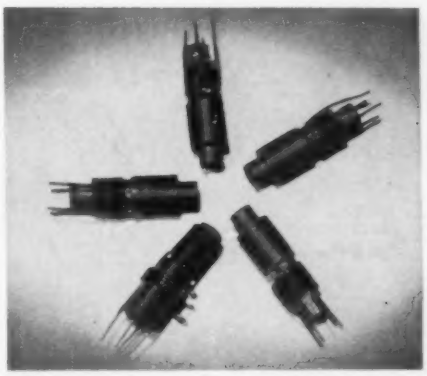
**Applications and markets**

Initially, the major outlet for polycarbonates will be in the electrical and electronic industries. The figure most frequently cited is that about 60% of all resin consumption will be in those two fields. Specific products include coil forms, data processing components, dials, wire coating, magnetic tape, switchboard connectors, relay bases, insulating screws, terminal boards, printed circuit card holders, battery and barrier parts, housings, windows and covers, and current-carrying support parts.

The remaining 40% will be divided into the industries mentioned earlier in the article. However, no figures are available on exactly how this will be distributed. But it is generally felt that housings for small motorized appliances may turn out to be a big volume item and that transportation, provided the price is right, may also consume sizable poundages —tail lights, steering wheels, aircraft light lenses, to name just a few.

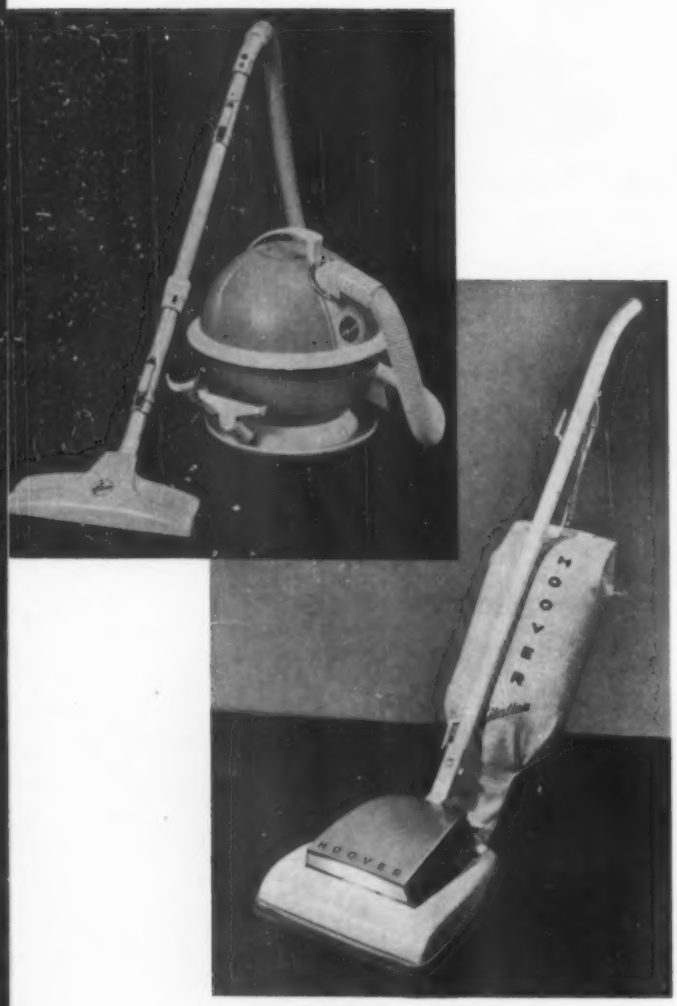
Specialized lighting applications may also be a market. Here the factors of transparency and high-temperature resistance offer important design advantages.

Film has already established a strong market position as a drafting medium and photographic base. While packaging uses are not presently foreseen, the field of drafting film and magnetic tape seems to hold promise, although it will experience stiffer competition from polyester tape. As was stated earlier in this article, polycarbonates can be processed by any of the conventional techniques, but much of the technology remains to be developed. The technique on which most work has been done is injection molding. Technical literature published by the companies involved in this field provides full details on molding conditions. But some basic points may be in order here. Molds made for polystyrene, nylon, methacrylate, and other thermoplastics can be used, (it's 0.005 to 0.007 in./in. for polycarbonates) but mold shrinkage factors must be kept in mind. Also, **(To page 178)**



**SOLUTION** of polycarbonate resin is used on these coils as cement to bond phenolic-paper spools and magnet wire. This is a General Electric application in which alkyd and phenolic insulating varnishes were replaced. Polycarbonate is non-corrosive, even when it is used with fine, 1-mil magnet wire.

# Plastics in the product revolution:




**IT'S A FAR CRY** from Hoover's first cleaners to today's Hoover Constellation (top) and Citation (above). And plastics had a big hand in the change.

When the first vacuum cleaners were introduced in the early 1920's, the housewife was given what was probably one of the heaviest "portable" appliances. In contrast, today's cleaners no longer require Amazon strength on the part of the user. Instead, they are relatively lightweight, sleek appliances that can be operated with little effort to do a good job. And what brought about this metamorphosis? Among other things, increased plastics usage.

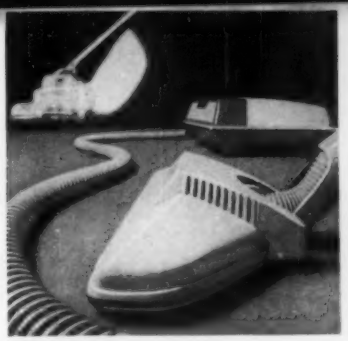
In 1959, the domestic vacuum cleaner industry marketed 3,420,830 units of the standard-size upright and canister models, representing a retail value of over $315,000,000. Based on an average of 3 to 3½ lb. of plastics material per unit, the poundage used yearly by this industry would be between 10 and 11½ million pounds. Plastics used in related products—small hand vacuum cleaners, industrial cleaners, rug shampooers, floor washers, etc.—would undoubtedly swell this total by a few million additional pounds.

Almost from the beginning of vacuum cleaner production, phenolic materials went into motor commutators, brush tube insulators, and electrical plugs. Ureas and melamines were also used for these parts.

Phenolics soon branched out into other areas. As early as 1926, a vacuum cleaner motor housing was molded of this material for Scott & Fetzer Co., Cleveland, Ohio. Other manufacturers followed suit: The Hoover Co. in the early '30s with a molded phenolic motor "cover," and Westinghouse Electric Corp. in 1932 with a hand vacuum cleaner of which the

**PLASTICS COMPONENTS** in Sunbeam's Dual-Deluxe canister model are (l. to r., clockwise): accessory tools of impact styrene and vinyl; tool bag of polyethylene; suction hose of vinyl; canister handle of styrene acrylonitrile; canister cover of ABS; guard bumper of vinyl; and wheel of vinyl.

# THE VACUUM CLEANER



**THE COVER:** Largely thanks to plastics, there have been some drastic changes in vacuum cleaner design from the first unit (Hoover, ca. 1924) to current models (RCA Whirlpool F90-20) shown in foreground. For what the new Hoovers look like, see photos at left. Rug by Cabin Craft of Du Pont nylon.

motor housing, fan chamber, and nozzle were of molded phenolic. In the mid-'40s, Westinghouse introduced an "all plastic" model, with the entire cleaner body, motor housing, fan and brush roll, all encased in phenolic.

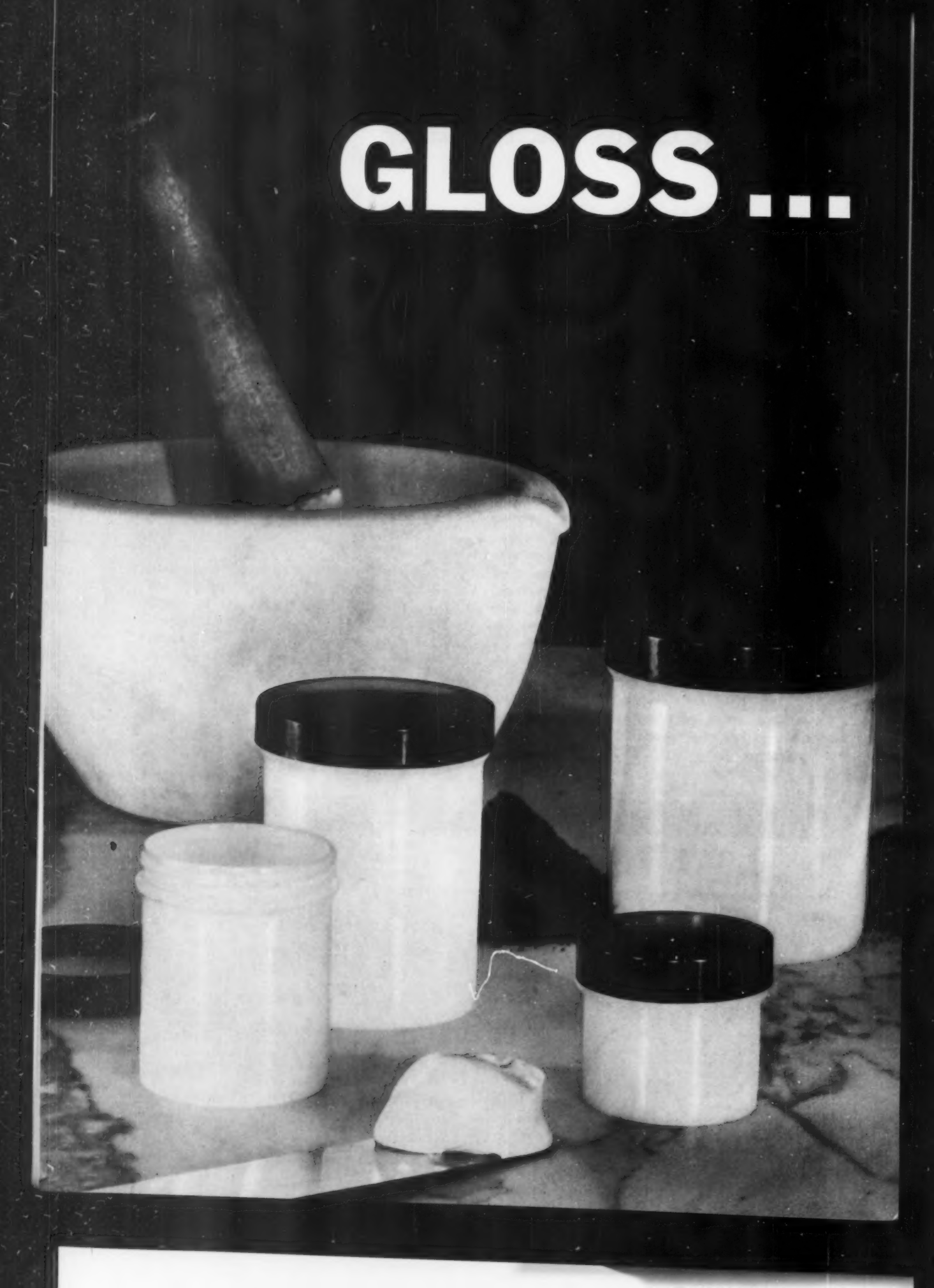
**Enter the thermoplastics**

Though the phenolic-housed cleaners were eventually discontinued, the slack in plastics usage was rapidly taken up by thermoplastics material. The Singer Manufacturing Co. was first, in the late 1930's, to use elastomeric vinyl for guard bumpers. With the introduction of canister-type models, this material became a popular choice for vacuum cleaner hose coverings. In recent years braided polyethylene has also been widely used. For the accessory tools of these canister cleaners today, the materials generally used are vinyl, high-impact styrene, ABS (acrylonitrile-butadiene-styrene), acetate, and butyrate. Nylon has long been regarded as the best material for bearings, small wheels, electrical switch components, and locking cams for the cleaner accessory tools. Delrin has recently entered the vacuum cleaner picture as motor support bearings, gears, and cord clips on the new General Electric Co. models. And polypropylene, which several manufacturers mold into wheels for canister cleaners, has also been used by General Electric as brush filament materials. In any true appraisal of the present position of plastics in the vacuum cleaner industry (see table below), one fact should be remembered: that really big usage of plastics is yet to come. MODERN PLASTICS recently queried 17 leading manufacturers of vacuum cleaners on their current use of plastics materials. Out of the large response came indications that plastics have made great strides as materials for cleaner accessory tools and small component parts, but that practically all housings, the big item in production, have remained in metal.

Further plastics usage in vacuum cleaners will occur by means of two important factors: the development of low-cost thermoplastics with all the necessary mechanical properties, and a growing enthusiasm for and acceptance of these and other plastic materials by the consuming public.—**End**

**Typical applications of plastics in vacuum cleaners**

| | Electrolux (Auto F Model) | Eureka (Model 1010) | General Electric (Model C-7) | RCA Whirlpool (Model F90-20) | Singer | Sunbeam (Dual Deluxe Model) | Westinghouse (Model MC-4) |
|---|---|---|---|---|---|---|---|
| **Handle** | Vinyl | Vinyl | | ABS | High-impact Polystyrene | Styrene-Acrylonitrile | High-impact Polystyrene |
| **Hose** | Polyethylene | Linear Polyethylene | Polyethylene | Vinyl | | Vinyl | Vinyl |
| **Motor Cover** | | | Phenolic | | | ABS | |
| **Cleaning Tools** | Rubber Modified Styrene, Vinyl | Vinyl, Butyrate Ethyl-Cellulose | ABS, Butyrate | Acetate | High-impact Polystyrene | High-impact Polystyrene, Vinyl | High-impact Polystyrene, Vinyl |
| **Bumper** | Vinyl | Vinyl | Vinyl | Vinyl | Vinyl | Vinyl | |
| **Gears and Bearings** | | | Phenolic, Nylon, Acetal Resin | | | Nylon | |
| **Wheels** | Phenolic, ABS | Medium-Density PE | Phenolic | Phenolic, Nylon, Polyethylene | Polypropylene | | Vinyl Tires |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Call on our technical knowledge and plastics experience to aid in applying these materials to your product. Mail the coupon today, or write a description of your requirements directly to Dept. BT-87, Union Carbide Plastics Company, Division of Union Carbide Corporation.

**TYPICAL PROPERTIES OF DMD-7000**

| Properties | ASTM Test | Typical Value |
|---|---|---|
| Density, gm/cc | D 792 | 0.96 |
| Melt Index, gm/10 min. | D 1238 | 5.0 |
| No-Load Heat Distortion Temperature* | | 130°C. (266°F.) |
| Secant Modulus (stiffness), psi | D 638 | 150,000 |
| Tensile strength, psi | D 638 | 4600 |
| Ultimate Elongation, % | D 638 | 15 |
| Durometer Hardness "D" | D 1484 | 65 |

*Obtained on injection molded specimens

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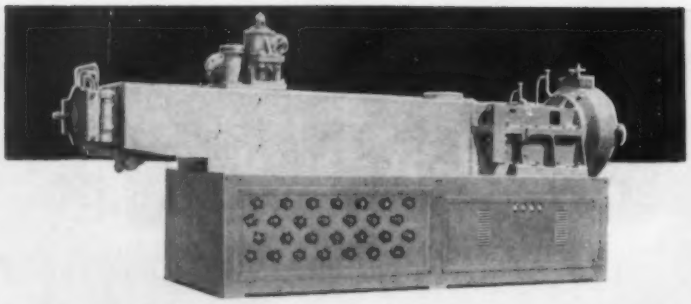

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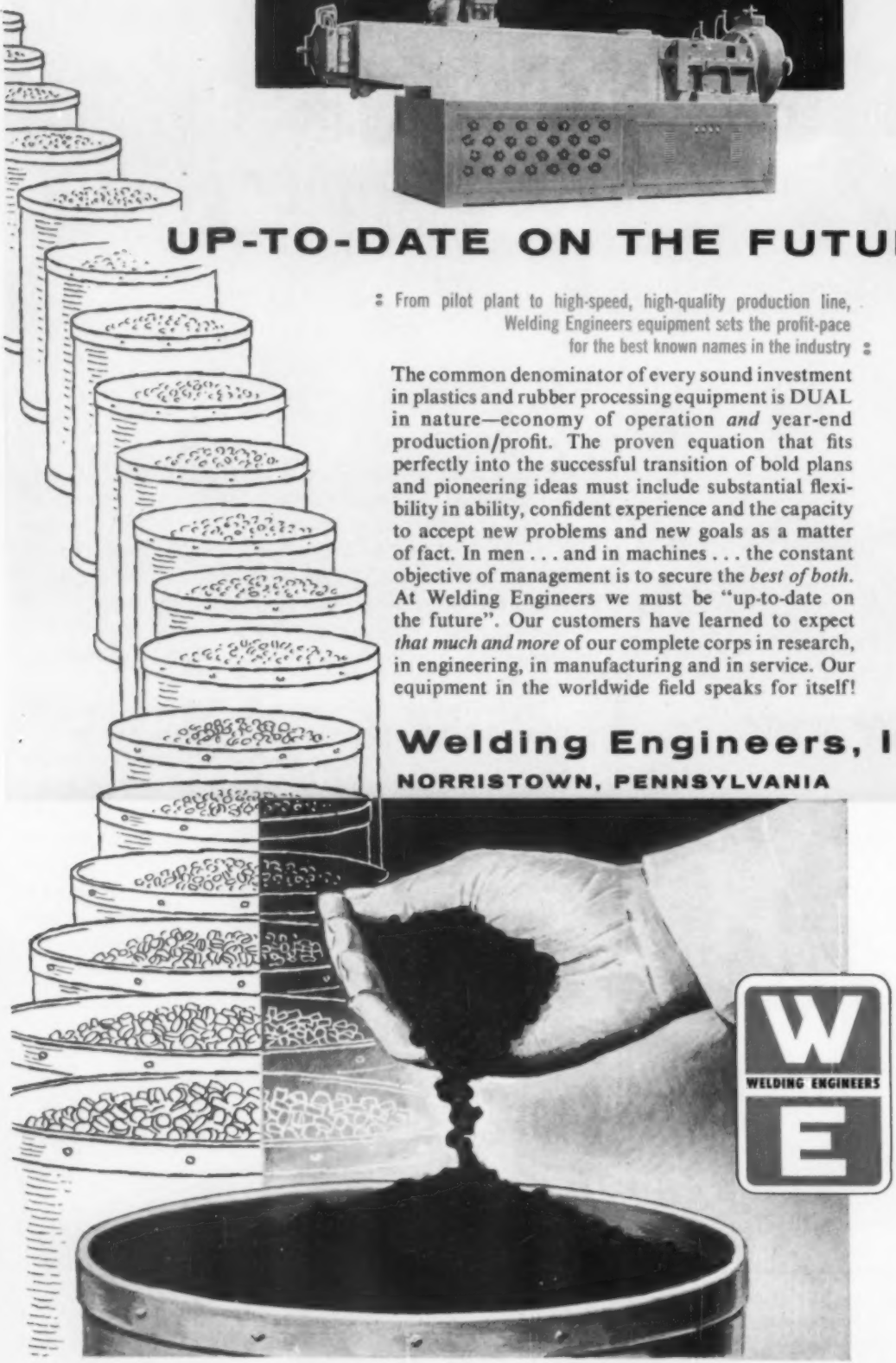


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# Extruding polypropylene films

By A. R. Gilden† and W. J. G. McCulloch†

Polypropylene resin can be extruded as a film by either of the two conventional methods using chill rolls or a water bath for cooling. Each process yields film with slightly different properties. Better balance of strength properties can be obtained with the chill roll process, while stiffer and somewhat glossier films are produced using the water bath. When the chill roll process was used, it was found that larger air gaps produce films with a better balance of strength properties between machine and transverse directions as well as higher clarity. Where an imbalance in strength properties is desired, short gaps should be used.

In the water bath process, this study indicates that water bath temperature is not a critical variable in determining the properties of the extruded polypropylene film. It was also found that when air gaps larger than ¼ in. were used between the die and the water a condition similar to surging was encountered. The causes of this behavior are not fully understood. Because of these limitations the use of a water bath limits the amount of control the operator has over the properties of the final film.

Polypropylene has several interesting properties which make it desirable as a film material; inherently high clarity, good barrier properties, excellent shelf life and the lowest specific gravity of the thermoplastics.

In order to take full advantage of these properties, it is necessary to process the resin in such a fashion as to minimize crystallite size and balance the strength properties in all directions in the plane of the film (maximize isotropy). This article presents results of processing experiments run in the Enjay Laboratories. Statistically designed, this extensive study investigated the effect of resin and processing variables on film properties. Two flat film extrusion-cooling techniques were studied: chill roll (cast film) and water bath. Polypropylene film can also be produced by extrusion-blowing, but this method was not included in the study.

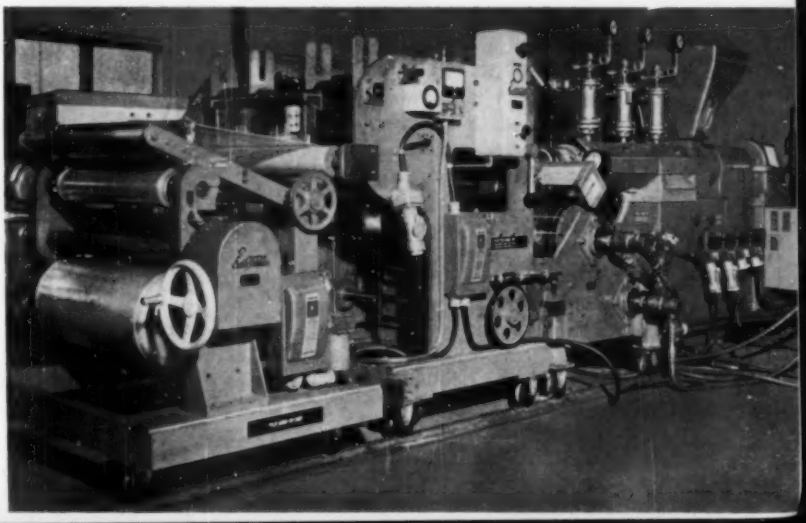
*Reg. U. S. Pat. Office
†Enjay Laboratories, Linden, N. J.
Adapted from a paper presented at the S.P.I. Palm Springs, Calif. Conference, April 8, 1960.

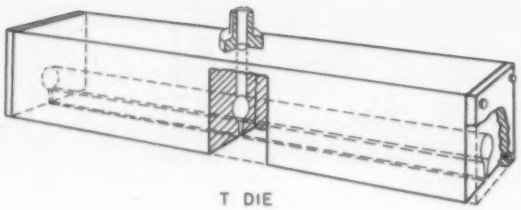
## Equipment and resins

The equipment used in the study consisted of a 2½-in. diameter screw extruder with a 20:1 length-to-diameter ratio. A 4:1 compression ratio metering type screw was used with a center-fed 28-in. slot-T film die. Cooling and take-off equipment included a double chill roll casting unit, a water bath which could be substituted for the rolls, a water chiller for roll temperature control, and conventional take-off and wind-up units. An overall view of the equipment with the chill roll unit in place is shown in Fig. 1, below, and drawings of dies used in the study are shown in Fig. 2, p. 112. Although data using the coat hanger die are not presented in this report, preliminary evaluation of this type of die indicates it is also excellently suited for the production of high quality polypropylene film.

A valved adapter, equipped with a Bourdon pressure gage, was used between the die and cylinder to monitor and study the effects of extrusion pressure. The nominal die blade opening used for all the film was 0.015 inch;

**FIG. 1:** Overall view of extrusion equipment used in the study with electronic treater and chill-roll unit in place.





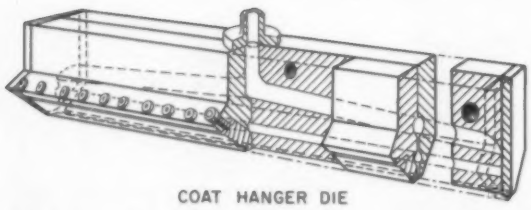




**FIG. 2:** Film dies used for polypropylene film study.

conditions were adjusted so that all films produced were of a 1-mil (0.001-in.) nominal thickness.

In general all of the equipment used was standard equipment used in polyolefin film production. No special modifications were required.

The resins used in the study are listed in Table I, right, and covered a wide range of melt indices and density. The physical properties of the extruded 1-mil films which were evaluated were those properties considered to be of major interest to the film processor: tear and impact strengths, haze, gloss, slip, and stiffness. To help interpret the results of the experimental runs, data on density, birefringence, crystallite size, and percent crystallinity of the film were also collected.

### Design of experiments

A random balance design was considered, however, it was felt that this type of experiment would not yield sufficiently reliable conclusions. In view of the limited amount of variables to be investigated, it was decided to use the full factorial experiment which, due to its balanced structure, was felt would give more reliable results. A description of the runs made will be found in the column headings of Table II, pp. 116-117, which presents results on films A and B, which were made by the chill roll process.

Using the chill roll technique, the full factorial experiment described in Table II was applied fully only to Resin A, with a melt index of 7.0 and a density of 0.902 to determine the most important variables. In the study of chill roll films from Resin B, films were extruded at only the higher pressure of 2400 p.s.i. The other resins shown in Table I were also studied by the chill roll process, except that in these latter runs only the higher pressure of 2400 p.s.i. and the nominal higher stock temperature of 550° F. were used. Gap sizes and other variables were as described.

Resin B and the other resins were also studied using the water bath techniques. It was not found possible to successfully make films of polypropylene in the water bath method at gaps larger than ¼ inch. When air gaps greater than ¼ in. were used at speeds of 150 ft./min., a condition resembling a surge resulted. A wavelike pattern in the melt is observed in the length of film between the die and the water and the resultant film has areas of thick and thin spots despite a nonsurging output from the extruder. This behavior, which is present in the extrusion of other linear polyolefins, is not fully understood at present; but, fortunately, can be easily eliminated by decreasing the gap size.

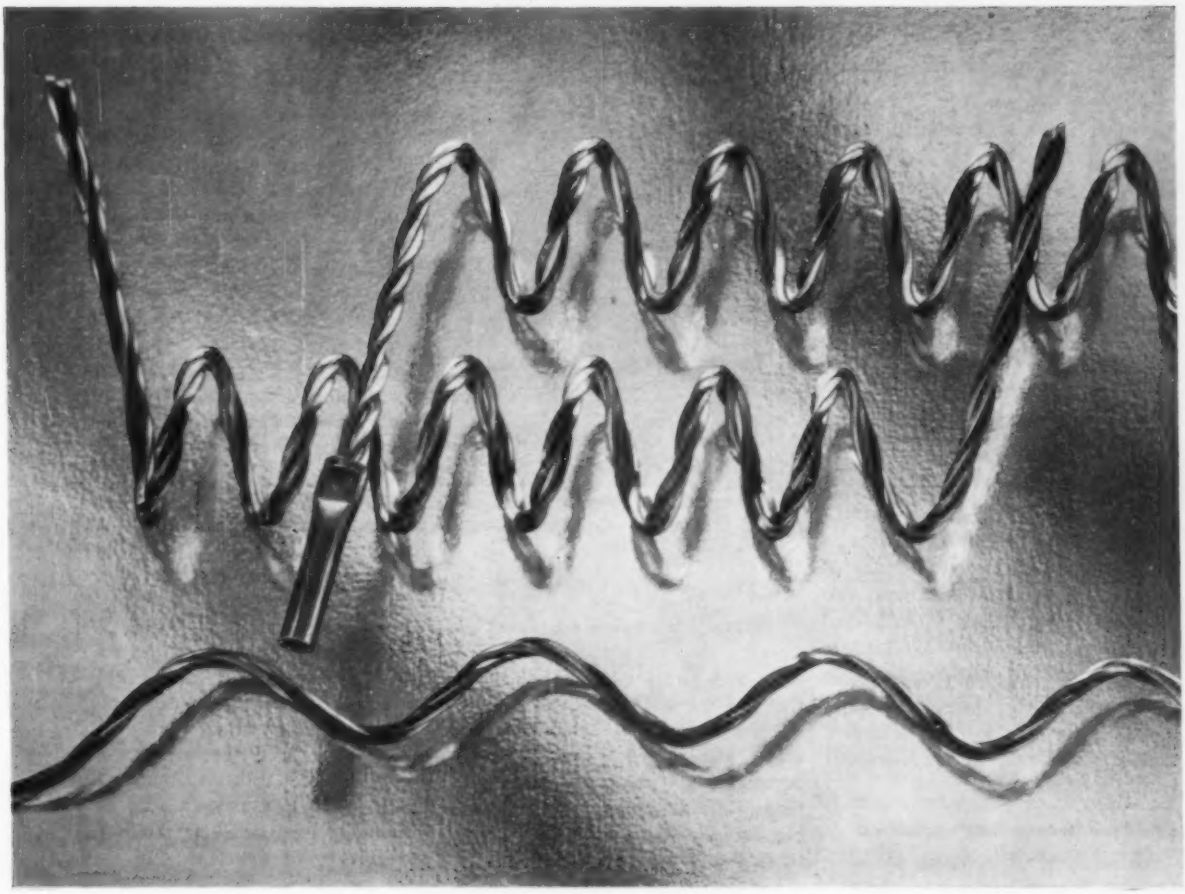
For water bath runs, the gap was kept at 5/16 to ¼ in., and the variables in the study were reduced to stock temperature, quench temperature, and film speeds. In addition to B, the other resins were also run using the water bath technique at the higher pressure and stock temperature only, since these conditions appeared optimum for producing films that possess high clarity and strength.

Stock temperatures during the various runs were maintained to ±5° F. of the desired level and quench temperatures of roll or bath were controlled to 83 ±3° F. and 107 ±3° F. levels. For clarity, values in the tables have been rounded to 500, 80° F., etc. The reported chill roll temperatures are the actual temperatures of the metal surface, which was checked with a roll pyrometer, since a temperature gradient was found to exist between the cooling water in the roll and the outside roll surface. Chill roll temperatures above 120° F. were possible only at short air gaps. Some sticking of the film to the roll (called "patching") occurred above this value when gaps of 2½ in. were used. Bath temperatures above 130° F. were not possible due to localized boiling of the water at the hot film surface, which caused blistery film especially at higher stock temperatures. In addition to the quench temperatures of 80 and

**Table I:** Density and melt index of the polypropylene resins used in the study.[a]

| *Resin* | *Density* g./cu. cm.[b] | *Melt index* g./10 min.[c] |
|---|---|---|
| A | 0.902 | 7.0 |
| B | 0.900 | 8.9 |
| C | 0.898 | 4.0 |
| D | 0.896 | 1.1 |
| E | 0.901 | 2.0 |
| F | 0.900 | 4.5 |
| G | 0.897 | 5.7 |
| H | 0.902 | 5.7 |
| I | 0.901 | 7.2 |
| J[d] | 0.900 | 8.9 |
| K | 0.900 | 10.3 |
| L | 0.902 | 15.7 |
| M | 0.902 | 40.0 |

[a]All resins were Escon polypropylenes. [b]At 23° C. [c]At 250° C. [d]A different resin than B.



# *3 new Sylvania coils give a new shine to vacuum metallizing quality*

Sylvania now brings you three big advances in vacuum metallizing coils—open-strand coils, aluminum core coils and copper-tipped coils. Each typifies Sylvania progress in this dynamic field.

Open-strand coils are ideal where large loads of aluminum are required. The uniform stranding holds more molten aluminum, assures more efficient aluminizing.

Aluminum core coils give proper initial wetting. They often completely eliminate the need for dry-run work in the vacuum chamber. Where dry runs are necessary, this greatly simplifies the aluminizing operation.

Copper-tipped coils provide a strong positive electrical contact between bus bar and coils when applications call for open-strand or aluminum core coils. Results—more uniform heat distribution between the coils, thus assuring longer coil life and better work coverage.

Whatever your needs—ribbon filament coils, aluminum oxide coated coils, vertical basket aluminizing coils, as well as stranded wire—Sylvania quality materials add quality to your vacuum metallized coatings. Chemical & Metallurgical Division, Sylvania Electric Products Inc., Towanda, Pennsylvania.

# SYLVANIA

*Subsidiary of* **GENERAL TELEPHONE & ELECTRONICS**

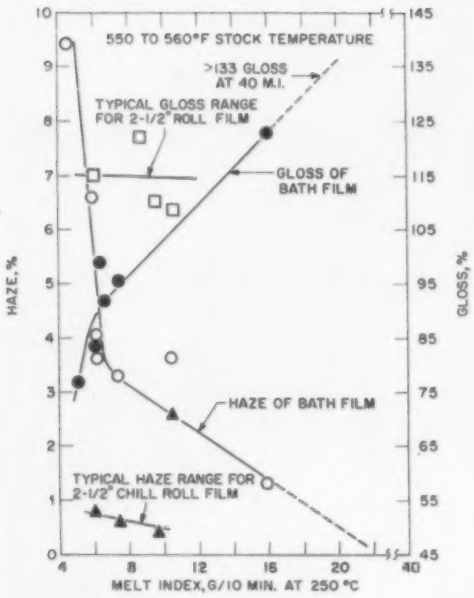

550 TO 560°F STOCK TEMPERATURE
>133 GLOSS AT 40 M.I.
TYPICAL GLOSS RANGE FOR 2-1/2" ROLL FILM
GLOSS OF BATH FILM
HAZE OF BATH FILM
TYPICAL HAZE RANGE FOR 2-1/2" CHILL ROLL FILM
HAZE, %
GLOSS, %
MELT INDEX, G/10 MIN. AT 250 °C

**FIG. 3:** Haze and gloss of polypropylene films as a function of resin melt index. Chill roll film at 1 in. air gap roughly falls on curves of haze of bath film.

110° F., side runs were made on some resins to determine the effects of varying chill roll or bath temperature on the film properties within the limits described.

### Effect of processing variables

An analysis of variance of the test data from Resin A was calculated using an IBM 704 computer. Several interactions were obtained which are explained more fully below. The results show only the basic trends that were obtained during this study on the effects of processing variables on properties. The results may differ materially from those obtained if operating conditions are used which are substantially out of the range studied. For example when a side run was made with Resin C, wherein chill roll quench temperatures were varied in excess of 115° F., a sharp increase in percent haze was obtained which was not evident in the other runs in the range of 80 to 110° F. used for the study. Although this was not an exhaustive study and much has yet to be learned about the extrusion of polypropylene film it is felt that the findings of this study will prove of assistance to processors in getting started with PP resins.

### Haze, gloss, clarity

Two of the striking properties of polypropylene as a film are its low haze and high surface gloss. As with the other polyolefins using the flat die extrusion technique, the lowest haze values are generally obtained at high stock temperatures, low chill roll temperatures, and large air gaps. For highest gloss, high stock temperatures should be used.

Films having roughly the same properties can be obtained using either the chill roll or water quench techniques, however, the processing parameters necessary in order to get equivalent films will, of course, not necessarily have the same values.

For example, films extruded onto a chill roll using an air gap of 1 in. have roughly the same haze and gloss as films extruded into a water bath using an air gap of ¼ inch.

A study of the effect of resin melt index on haze and gloss is shown in Fig. 3, left. The curves for bath film given in this data demonstrate the beneficial effect of increasing resin melt index on both properties.

Chill roll film haze and gloss values at air gaps of 1 in. roughly follow the water bath curves. Also shown in the graph are the effects on chill roll films of increasing the gap to 2½ in., which significantly lowers the haze and increases the gloss of the film so produced over the range of quench temperatures from approximately 80 to 110° F.

Stock temperature as might be expected was also an important factor in determining haze and gloss values. Data on Resin B shown in Fig. 4, below, illustrate the decrease in haze that takes place as stock temperatures increase and, in addition, shows the effect of increasing air gap in the chill roll process; water bath air gap being limited to ¼ in. only as previously mentioned at the beginning of this article.

In the full factorial experiment on Resin A using the chill roll technique, a 3-factor interaction was noted between stock temperature, film speed, and quench temperature. At a stock temperature of 500° F. and 100 ft./min. film speed, haze increased as quench temperatures increased. However, when film speed was increased to 150 ft./min. during the experiment, a rising quench temperature had

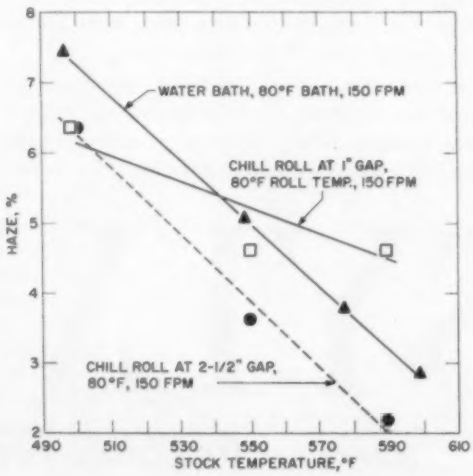
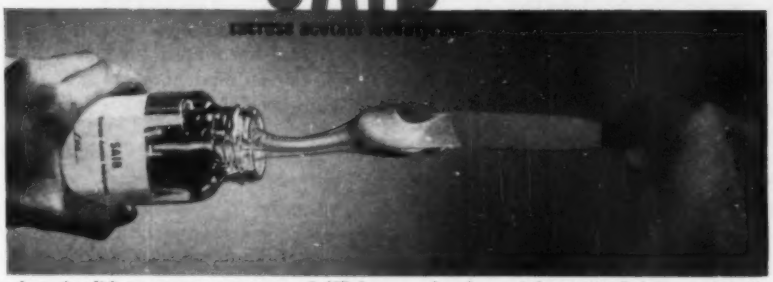

WATER BATH, 80°F BATH, 150 FPM
CHILL ROLL AT 1" GAP, 80°F ROLL TEMP., 150 FPM
CHILL ROLL AT 2-1/2" GAP, 80°F, 150 FPM
HAZE, %
STOCK TEMPERATURE, °F

**FIG. 4:** Effect of stock temperature on haze of films that were made from Resin B.

# Unique function of SAIB aids plastics processors



*A semi-solid at room temperature, SAIB has a molecular weight of 838. It is exceptionally light in color and unusually stable to ultraviolet light. SAIB exhibits outstanding hydrolysis and thermal stability. (Less than 0.1% is hydrolyzed after refluxing 96 hours with water. Heated to 175°C. for a period of 6 days, its color increases slowly to straw yellow, with no appreciable change occurring until after 24 hours of heat-aging.) SAIB is compatible with a wide variety of polymers, modifiers and plasticizers and is highly soluble in most common solvents. (A 90% solution of SAIB in ethyl alcohol has a viscosity of only 750 centipoises at 30°C.)*

When used in conjunction with dimethyl phthalate and other common plasticizers, SAIB offers processors of cellulose acetate plastics the means of achieving

*easier dry-blending*
*faster molding cycles*
*increased extrusion rates*
*improved physical properties*

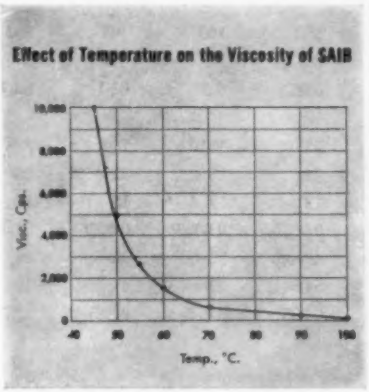
### SAIB aids in dry-blending

SAIB deactivates the cold solvency characteristics of dimethyl phthalate and similarly-active plasticizers. By blending SAIB with the plasticizer before compounding, even distribution of the plasticizer throughout the cellulose acetate mix is readily accomplished, eliminating the problem of paste formation.

### SAIB increases molding and extruding rates

The presence of SAIB in a plasticized cellulose acetate formulation permits faster, more uniform flow through extrusion and molding cylinders *without decreasing hardness or flexibility*.

As illustrated in the graph, SAIB has an extremely high temperature-viscosity index. Note that at 70°C., its viscosity is less than 1,000 centipoises. Below this temperature, however, a sudden increase occurs. At 50°C., its viscosity is approximately 4,500 centipoises. At room temperature, it becomes a semi-solid.




At molding or extrusion temperatures, SAIB aids in plasticization, while at room temperature it has the opposite effect, stiffening the plastic and increasing its surface hardness. This unique behavior of SAIB permits molding and extrusion conditions applicable to a material one or two flows softer than its hardness and rigidity at room temperature would indicate.

Similarly, in vacuum-forming, cellulose acetate sheeting formulated with a dimethyl phthalate-SAIB blend submits to deeper drawing before blushing occurs, again because of this unusual temperature-viscosity relationship.

### SAIB improves physical properties

Modification of cellulose acetate formulations with SAIB increases hardness, rigidity and tensile strength, and decreases weight loss on accelerated aging.

Note that this improvement in physical properties achieved at practical flow temperatures is due to the behavior of SAIB and not to a decrease in plasticizer content. Dimethyl phthalate-SAIB formulations exhibiting physical characteristics in the range of H 5 or H 6 have been extruded without difficulty.

### Hot melts, peelable coatings

With its excellent permanence, compatibility and stability characteristics, SAIB can be used to advantage in hot melt and peelable plastic formulations.

Tough, flexible melt coatings can be made containing up to 70% SAIB. One of their outstanding features is a complete absence of fuming at melt temperatures. Operating temperatures are lower, too. The usual application temperature for conventional butyrate hot melts is 350°F. With high SAIB modification, optimum operating temperature is only 275°F.

In ethyl cellulose compositions, SAIB acts as a solubilizer for mineral oil, reducing exudation of the oil from the film and enabling the formulator to use increased amounts of oil.

In peelable coatings, SAIB improves resistance to exudation, thus maintaining flexibility.

SAIB is so unusual—acting as a plasticizer under certain conditions, and as resin extender under others—you will want to try it in your own formulations, under your own processing conditions. You can get a sample of SAIB, as well as a technical report on its physical properties and performance, by writing to your nearest Eastman sales office or to EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENN.

**SAIB**
**SUCROSE ACETATE ISOBUTYRATE**

**Eastman** CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company

**SALES OFFICES: Eastman Chemical Products, Inc.,** Kingsport, Tennessee; Atlanta; Chicago; Cincinnati; Cleveland; Detroit; Framingham, Massachusetts; Greensboro, North Carolina; Houston; New York; Philadelphia; St. Louis. **West Coast: Wilson and Geo. Meyer & Company,** San Francisco; Los Angeles; Portland; Salt Lake City; Seattle.

negligible effect on haze at the 500° F. stock temperature.

When the stock temperature was increased to 550° F., the effect of quench temperature on haze at the different speeds was roughly reversed. That is, increases in quench temperature increased haze more at the higher film speed of 150 ft./min. than at the lower film speed of 100 ft./min., contrary to the behavior at the lower stock temperature of 500° F. using Resin A.

Resin properties must also play a part in this behavior, since a study of Resin B showed a lower dependence of haze on quench temperature than was observed with Resin A above. To further investigate the effect of chill roll temperature on haze and gloss, this variable was studied more extensively in a special set of runs

**Table II:** Results of factorial experiment on Resins A and B—Chill roll process

| Stock temp., °F. | 500 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Chill roll temp., °F. | 80 | | | | 110 | | | |
| Film speed, ft./min. | 100 | | 150 | | 100 | | 150 | |
| Air gap, in. | 1 | 2½ | 1 | 2½ | 1 | 2½ | 1 | 2½ |
| Valve pressure, 1100 p.s.i. | 101[b] | 102 | 103 | 104 | 201 | 202 | 203 | 204 |
| 2400 p.s.i. | 105 | 106 | 107 | 108 | 205 | 206 | 207 | 208 |
| **Resin A, 1,110 p.s.i.** | | | | | | | | |
| Code | 101 | 102 | 103 | 104 | 201 | 202 | 203 | 204 |
| Haze, % | 3.7 | 3.5 | 5.9 | 6.9 | 6 | 5 | 5.7 | 4.7 |
| Impact strength, ft./lb. | 0.20 | 0.95 | 0.60 | 0.51 | 0.67 | 0.27 | 0.23 | 0.305 |
| Tear strength, g./mil | | | | | | | | |
| TD | 694 | 935 | 1110 | 776 | 388 | 59 | 495 | 154 |
| MD | 16 | 24 | 26 | 21 | 25 | 18 | 19 | 18 |
| Stiffness, (Handle-O-Meter[a]), g. | 11.5 | 13 | 17 | 15 | 16 | 14 | 18 | 22 |
| Birefringence | 0.0030 | 0.0030 | 0.0038 | 0.0038 | 0.0035 | 0.0022 | 0.0038 | 0.0029 |
| Crystallite size, Å | 52-60 | 46-55 | 52-60 | 42-50 | 96 | 83 | 87 | 79 |
| Crystallinity, % | 33 | 54 | 37 | 41 | 49 | 50 | 44 | 50 |
| Density g./cu. cm. | 0.885 | 0.885 | 0.885 | 0.885 | 0.891 | 0.891 | 0.892 | 0.894 |
| **Resin A, 2,400 p.s.i.** | | | | | | | | |
| Code | 105 | 106 | 107 | 108 | 205 | 206 | 207 | 208 |
| Haze, % | 3.8 | 3.9 | 4.9 | 4.1 | 5.3 | 4.3 | 4.4 | 4.9 |
| Impact strength, ft./lb. | 1.12 | 0.84 | 0.54 | 0.86 | 0.41 | 0.28 | 0.21 | 0.20 |
| Tear strength, g./mil | | | | | | | | |
| TD | 990 | 933 | 970 | 1043 | 752 | 63 | 888 | 99 |
| MD | 39 | 29 | 36 | 43 | 38 | 17 | 23 | 18 |
| Stiffness, (Handle-O-Meter[a]), g. | 8.5 | 13 | 10.5 | 10.5 | 14.5 | 12.5 | 10 | 11 |
| Birefringence | 0.0029 | 0.0032 | 0.0049 | 0.0030 | 0.0037 | 0.0024 | 0.0048 | 0.0027 |
| Crystallite size, Å | 48-55 | 44-50 | 50-55 | 51-73 | 74 | 76 | 74 | 71 |
| Crystallinity, % | 27 | 32 | 36 | 42 | 36 | 35 | 44 | 40 |
| Density g./cu. cm. | 0.885 | 0.884 | 0.885 | 0.885 | 0.889 | 0.894 | 0.889 | 0.892 |
| **Resin B, 2,400 p.s.i.[e]** | | | | | | | | |
| Code | 105 | 106 | 107 | 108 | 205 | 206 | 207 | 208 |
| Haze, % | 6.1 | 4.0 | 6.3 | 4.4 | 5.8 | 6.3 | 6.6 | 5.6 |
| Impact strength, ft./lb. | 0.25 | 0.88 | 0.20 | 0.74 | 0.23 | 0.23 | 0.19 | 0.29 |
| Tear strength, g./mil | | | | | | | | |
| TD[f] | [c] | 1000 | 1443[d] | [c] | 1088 | 451 | (1) | 544 |
| MD | 19.5 | 19.5 | 8.2 | 13.5 | 12.5 | 12.5 | 8.3 | 15 |
| Stiffness, (Handle-O-Meter[a]), g. | 15.5 | 8.5 | 13.5 | 12 | 13.2 | 9 | 13.2 | 12.2 |
| Birefringence | ——— Not measured ——— | | | | | | | |
| Crystallite size, Å | ——— Not measured ——— | | | | | | | |
| Crystallinity, % | ——— Not measured ——— | | | | | | | |

[a]Made by Thwing-Albert Instrument Co. [b]Code numbers (101, 105, 201, etc.). [c]Unable to obtain TD tear strengths for these samples due to breakage in MD at clamp jaws. [d]Did not tear. [e]Resin B run high pressure of 2400 p.s.i., only. [f]TD=transverse to machine direction; MD = machine direction.

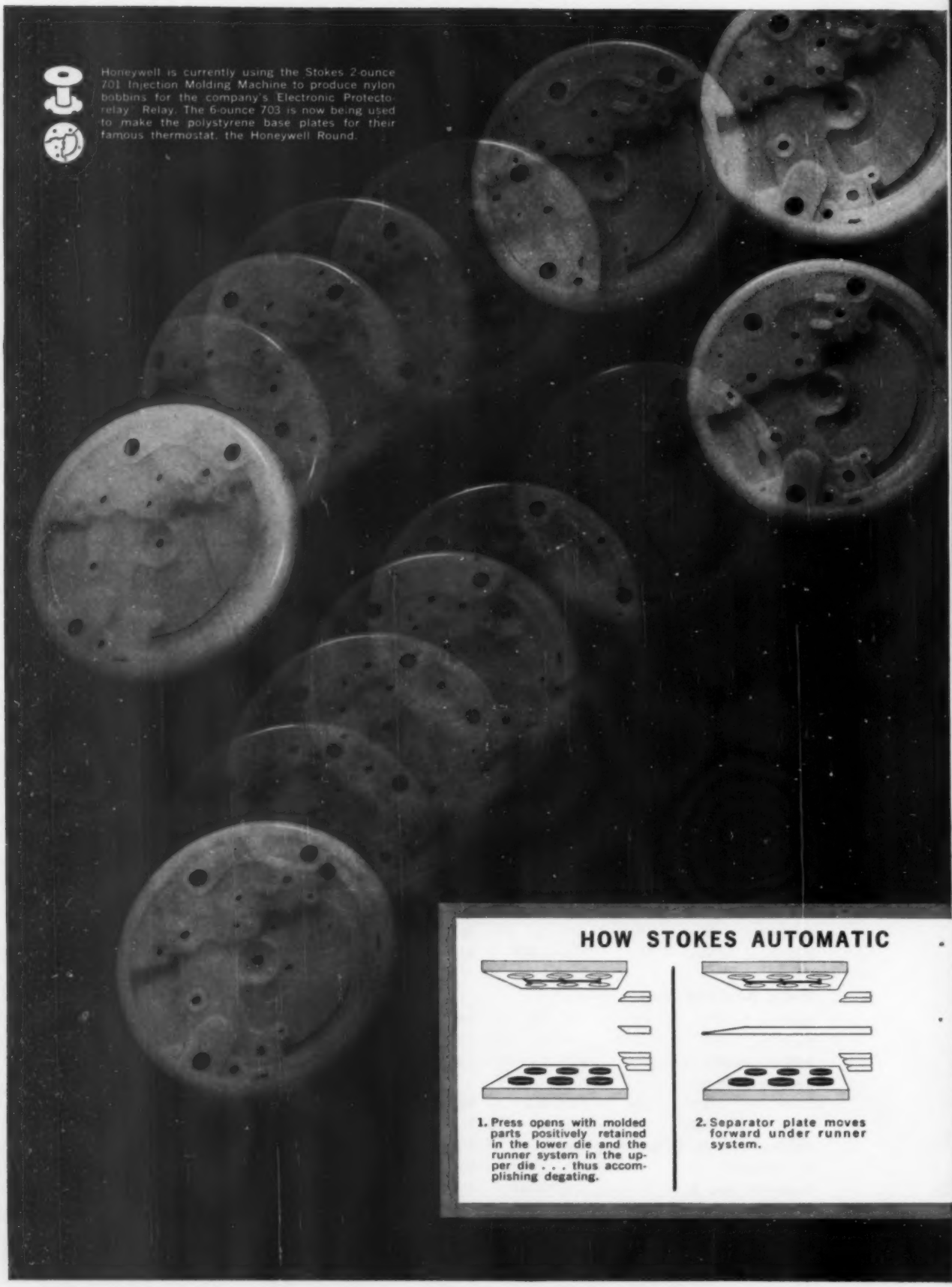
using Resin C. A 1½-in. air gap and a 545° F. stock temperature were used and held constant along with other variables as the chill roll temperature was varied from 55 to 125° F. as compared to the temperatures of 80 and 110° F. used on other runs. Under these conditions, film haze was negligible from 55 to 85° F., and rose to a maximum of about 7.5% at the higher quench temperature of 125° F. These data, along with data from the other resins, reinforced the conclusion that haze will vary from resin to resin; however, lowest haze values were generally obtained at chill roll temperatures that registered below 110° F.

Gloss measurements made on chill roll films of Resin C lead to the conclusion that gloss decreases slowly with **(To page 120)**

**Table II:** Results of factorial experiment on Resins A and B—chill roll process, continued

| Stock temp., °F. | 550 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Chill roll temp., °F. | 80 | | | | 110 | | | |
| Film speed, ft./min. | 100 | | 150 | | 100 | | 150 | |
| Air gap, in. | 1 | 2½ | 1 | 2½ | 1 | 2½ | 1 | 2½ |
| Valve pressure, 1100 p.s.i. | 301 | 302 | 303 | 304 | 401 | 402 | 403 | 404 |
| 2400 p.s.i. | 305 | 306 | 307 | 308 | 405 | 406 | 407 | 408 |
| **Resin A, 1,110 p.s.i.** | | | | | | | | |
| Code | 301 | 302 | 303 | 304 | 401 | 402 | 403 | 404 |
| Haze, % | 4.2 | 2.9 | 3.6 | 2.3 | 4.1 | 4.8 | 3.7 | 4.1 |
| Impact strength, ft./lb. | 1.13 | 0.93 | 1.18 | 0.68 | 0.30 | 0.29 | 0.24 | 0.18 |
| Tear strength, g./mil | | | | | | | | |
| TD | 756 | 78 | 822 | 166 | 83 | 53 | 80 | 40 |
| MD | 33 | 44 | 29 | 30 | 14 | 32 | 13 | 30 |
| Stiffness (Handle-O-Meter[a]), g. | 15 | 21 | 14 | 19 | 18 | 16 | 15 | 17 |
| Birefringence | 0.0019 | 0.0014 | 0.0027 | 0.0015 | 0.0025 | 0.0014 | 0.0030 | 0.0017 |
| Crystallite size, Å | 52-75 | 52-75 | 54-79 | 51-73 | 100 | 72 | 86 | 81 |
| Crystallinity, % | 24 | 30 | 30 | 29 | 35 | 64 | 38 | 43 |
| Density g./cu. cm. | 0.886 | 0.886 | 0.881 | 0.885 | 0.890 | 0.891 | 0.888 | 0.891 |
| **Resin A, 2,400 p.s.i.** | | | | | | | | |
| Code | 305 | 306 | 307 | 308 | 405 | 406 | 407 | 408 |
| Haze, % | 3.9 | 4.1 | 3.8 | 2.4 | 4.5 | 3.9 | 4.6 | 3.9 |
| Impact strength, ft./lb. | 1.55 | 1.09 | 0.96 | 0.62 | 0.27 | 0.26 | 0.25 | 0.20 |
| Tear strength, g./mil | | | | | | | | |
| TD | 758 | 184 | 856 | 247 | 194 | 58 | 218 | 20 |
| MD | 30 | 39 | 26 | 28 | 18 | 26 | 19 | 25 |
| Stiffness, (Handle-O-Meter[a]), g. | 10.4 | 13.5 | 7.0 | 16.7 | 16 | 16.5 | 12.5 | 17 |
| Birefringence | 0.0021 | 0.0015 | 0.0025 | 0.0018 | 0.0026 | 0.0015 | 0.0035 | 0.0018 |
| Crystallite size, Å | 46-60 | 50-70 | 57-84 | 50-70 | 60 | 65 | 72 | 81 |
| Crystallinity, % | 25 | 23 | 34 | 27 | 50 | 44 | 49 | 43 |
| Density g./cu. cm. | 0.884 | 0.884 | 0.886 | 0.885 | 0.890 | 0.890 | 0.890 | 0.891 |
| **Resin B, 2,400 p.s.i.[e]** | | | | | | | | |
| Code | 305 | 306 | 307 | 308 | 405 | 406 | 407 | 408 |
| Haze, % | 3.7 | 3.2 | 4.7 | 3.7 | 3.6 | 5.0 | 3.7 | 5.2 |
| Impact strength, ft./lb. | 0.45 | 0.83 | 0.60 | 0.78 | 0.52 | 0.84 | 0.39 | 0.55 |
| Tear strength, g./mil | | | | | | | | |
| TD[f] | 956 | 698 | 956 | 900 | 826 | 122 | 799 | 298 |
| MD | 26 | 29 | 17 | 19 | 21 | 34 | 18 | 43 |
| Stiffness, (Handle-O-Meter[a]), g. | 11 | 9.5 | 7.5 | 11.5 | 8 | 8 | 9.2 | 10 |
| Birefringence | 0.0030 | 0.0018 | 0.0028 | 0.0021 | 0.0027 | 0.0014 | 0.0035 | 0.0017 |
| Crystallite size, Å | 56-82 | 53-76 | 68 | 58-69 | 53-75 | 51-71 | 53-76 | 51-71 |
| Crystallinity, % | 29 | 33 | 34 | 20 | 34 | 23 | 39 | 31 |

[a]Made by Thwing-Albert Instrument Co. [b]Code numbers (101, 105, 201, etc.). [c]Unable to obtain TD tear strengths for these samples due to breakage in MD at clamp jaws. [d]Did not tear. [e]Resin B run high pressure of 2400 p.s.i., only. [f]TD=transverse to machine direction; MD = machine direction.



Honeywell is currently using the Stokes 2-ounce 701 Injection Molding Machine to produce nylon bobbins for the company's Electronic Protecto-relay. Relay. The 6-ounce 703 is now being used to make the polystyrene base plates for their famous thermostat, the Honeywell Round.

## HOW STOKES AUTOMATIC



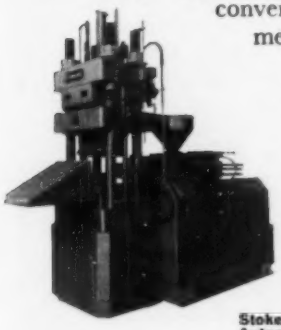
1. Press opens with molded parts positively retained in the lower die and the runner system in the upper die . . . thus accomplishing degating.

2. Separator plate moves forward under runner system.

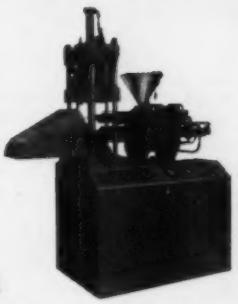
# AUTOMATION-MINDED HONEYWELL SELECTS STOKES TRULY AUTOMATIC INJECTION PRESSES

As an acknowledged leader in the field of automatic control, Honeywell knows automation . . . and knows what automation can do to reduce costs and improve the quality of many products. That's why in selecting injection molding equipment for the company's own production line, Honeywell wanted all the automation it could get. That meant Stokes 701 and 703 Truly Automatic Injection Molding Machines.

Honeywell likes the way these Stokes automatic presses operate . . . molding, degating, ejecting and sorting operations . . . all automatically! Injection time is reduced from the conventional 8 seconds to a mere 3 seconds. The attendant need only load the material into the hoppers and remove finished pieces in bulk. Even the sprues and runners are channeled to separate bins.



Stokes 6-ounce 703 Automatic Injection Molding Machine



Stokes 2-ounce 701 Automatic Injection Molding Machine

Honeywell has found valuable these exclusive features of the Stokes 701 and 703 machines: • Positive nozzle shut-off and full pressure pre-packing of injection cylinder permit shorter production cycles • Unique "torpedo" design permits fast, thorough purging • Automatic ejection, stripping, and sorting save substantially on labor costs.

Discover for yourself what Honeywell and other leading manufacturers have found to be the many cost and quality advantages of truly automatic injection molding machines. Write for Bulletin 203 which gives complete details on the Stokes Models 701 and 703. Be sure to ask for a Stokes production analysis on your particular application requirements.

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**PLASTICS EQUIPMENT DIVISION**

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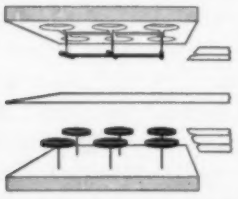
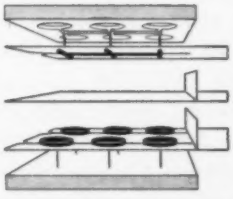
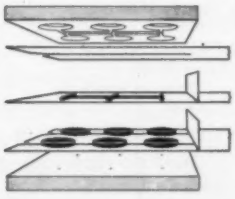
## EJECTION AND STRIPPING SYSTEM WORKS



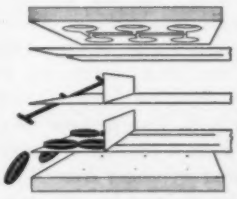
3. Knock-out pins eject the parts and runner system.



4. Separate slotted combs for parts and runners move forward into stripping position.



5. Ejector pins are retracted, stripping parts and runner system. Parts remain on lower comb and runner system falls on separator plate.



6. Wipers assure controlled removal of parts from comb and runners from separator plate into separate chutes.

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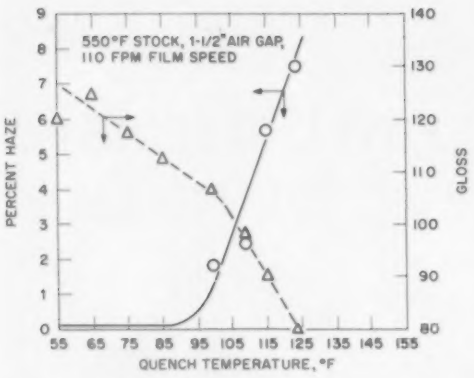


**FIG. 5:** Effect of quench temperature on haze and gloss of chill roll cast film made from Resin C.

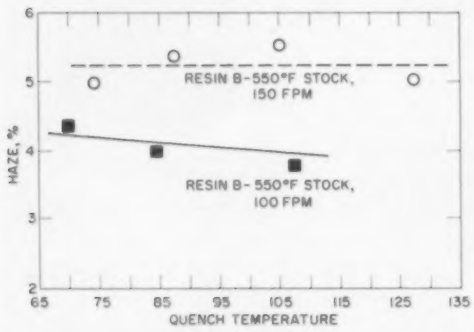


**FIG. 6:** Effect of water bath temperature on the haze of films made by this process (Resin B).

quench temperatures up to 100° F. However, above this temperature gloss is lost rapidly.

In Fig. 5, above, the effect of chill roll temperature on haze and gloss is plotted from data obtained on the study made on Resin C. Based on the information that was obtained from this study, it is recommended that one should operate at chill roll temperatures below 90° F. to optimize the haze and gloss properties of polypropylene film.

Contrasted to chill roll film processing, there is little effect on haze when water bath temperature is varied from 75 to 127° F. This might be due to the very small air gaps of ¼ in., which had to be used due to the difficulty that has been mentioned previously. Data on haze of Resin B water bath films are shown in the data plotted in Fig. 6, above.

Visual eyechart overall clarity was determined for all films run. Because all of the polypropylene films had excellent "see-through," this test was actually not sufficiently sensitive to detect any overall clarity differences.

A statistical analysis of all of the data obtained indicated certain major effects of the processing variables on haze and gloss. The general trends are summarized in Table III, below.

### Impact strength

The impact strength of polypropylene film was found to be mainly dependent on stock temperatures and air gap. Using the chill roll technique, films produced at a 2½-in. air gap were found to have significantly better impact strengths than films roll cast with an air gap of 1 inch. However, films made by the chill roll method even at the lower air gap of 1 in. were generally slightly to considerably better than the films made by the water bath technique using the ¼-in. air gap.

All resins studied showed an increase in impact strength when the air gap in the chill roll set-up was increased; however, the amount of increase was found to vary from resin to resin, indicating that some other factor—such as molecular weight distribution—may also play an important role.

On some spot runs, the air gap was increased up to 4 in. with further increases in impact strength, however, these increases were slight in the range between 2½ and 4 inches. At the large gap distances of 4 in., "neck-in" and other problems arise.

Chill roll temperature also affected the impact strength of the film. In the factorial experiment with Resin A, a stock temperature-chill roll temperature interaction was present. Increasing the stock temperature from 500 to 550° F., using an 80° F. chill roll temperature, increased impact

**Table III:** Effects of increases in processing variables on physical properties of film.

| *Property* | *Stock temp.* [a] | *Quench temp.* [a] | *Air gap* [a] | *Film speed* [a] |
|---|---|---|---|---|
| Haze | | | | |
| Cast | − | ± | − | + |
| Bath | − | 0 | [b] | + |
| Gloss | | | | |
| Cast | + | +0 | sl+ | 0 |
| Bath | + | 0 | [b] | 0 |
| Impact strength | | | | |
| Cast | − | sl− | + | − |
| Bath | sl+ | sl− | [b] | − |
| Machine-direction tear | | | | |
| Cast | + | − | + | − |
| Bath | 0 | 0 | [b] | sl− |
| Transverse-direction tear | | | | |
| Cast | − | − | − | + |
| Bath | | | [b] | |
| Coefficient of friction | | | | |
| Cast | + | − | sl+ | 0 |
| Bath | sl+ | 0 | [b] | 0 |

[a] + equals increase; − equals decrease; 0 equals no effect; ± equal interaction with other variables. [b] Only ¼-in. gap used for water bath film.

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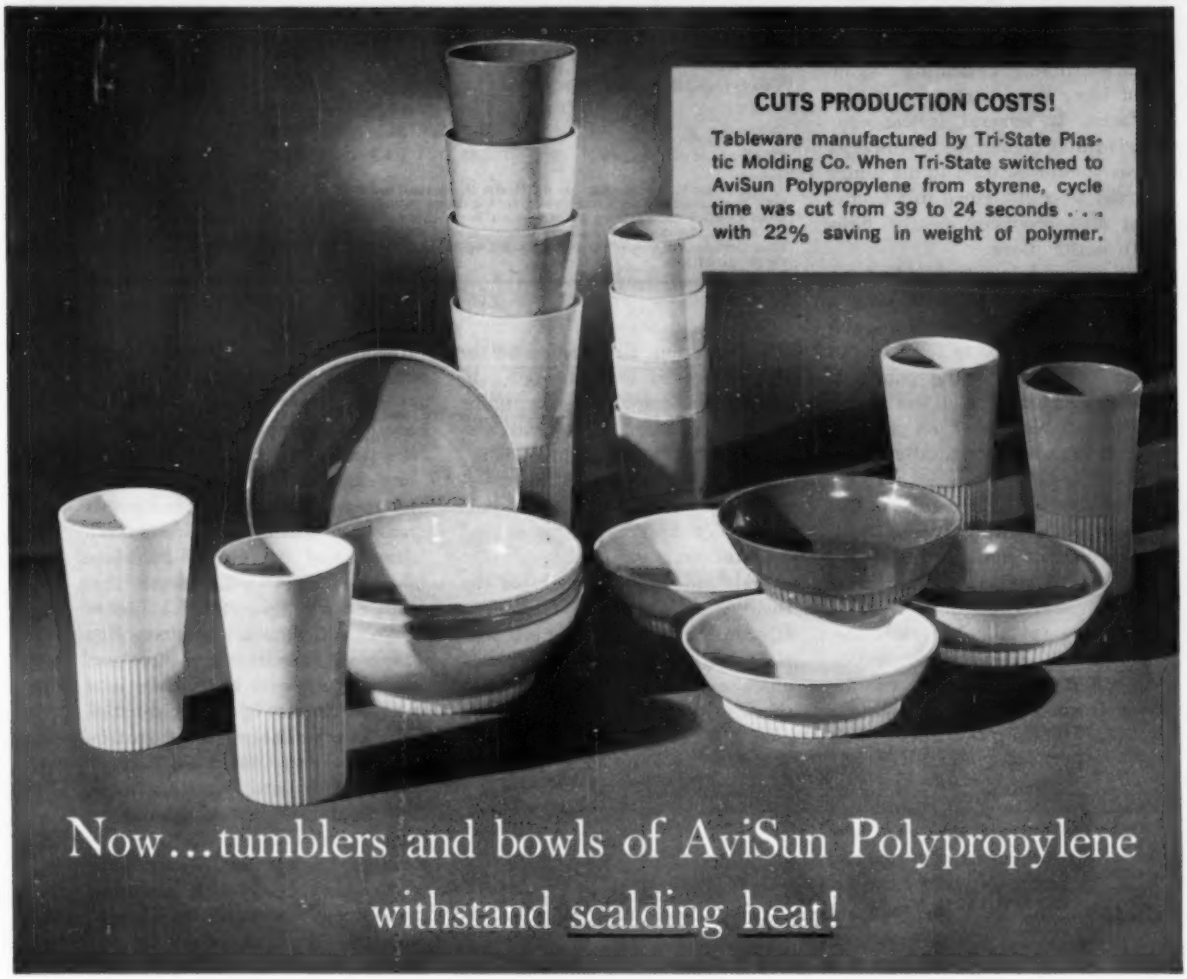

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strength. When using a 110° F. chill roll temperature, a slight decrease in impact strength was observed when the stock temperature was increased as above. However, Resin B showed an increase in impact strength with increasing stock temperature at both low and high chill roll temperatures, as did water bath films of Resin B using different quench temperatures, indicating again that basic resin structure is also a factor. In general, it was concluded that higher stock temperatures should be used to maximize impact strength, since this condition also produces clearer films with better gloss.

Film speed had little effect on film impact strength with only a slight decrease noted as film speed increased from 100 to 150 ft./min., other conditions being constant. The general effects of the major processing variables on impact are summarized qualitatively in Table III.

**Tear Strength.** Because of the orientation resulting during draw down, tear strength in the direction of film take-off or machine direction and strength in the direction perpendicular to the take-off or transverse direction will differ with processing conditions which determine the amount of orientation. In addition to the differences in tear strength observed, the amount of orientation in the resultant films was also checked by birefringence measurements. The lower the birefringence value, the more balanced, or freer from preferred orientation, is the film.

Melt index and density of the resin were found to have little effect on machine direction tear strengths over the range of variables evaluated. However, with the use of very low melt index resins (<2.0), lower tear strengths were observed.

Method of processing also had an effect on the tear strength of the polypropylene film. As might be expected, machine direction tear strengths were lower for water bath films since more cold drawing of the film takes place than in the chill roll process. This cold drawing results in a higher degree of film orientation. This preferred orientation in the machine direction of water bath films was borne out by the birefringence check. There is an 8- to 10-fold increase in birefringence values with bath film illustrating the greater degree of orientation that is present.

When using the water bath technique, it was also observed that stock and water bath temperatures had no effect on the machine direction tear strengths of films, due to the fact that the cold drawing and orientation in the water bath far outweigh any effects of these variables.

As with other properties, the machine direction tear strength of chill roll films was affected by the air gap distance. At a stock temperature of 550° F. and a 2½-in. air gap, machine direction tear strength was maximized while transverse direction tear strength decreased. Thus, increasing gap distance resulted in a film with more balanced tear strength properties. This trend was also noted in Resins D through M at the 80° F. chill roll temperatures. This was confirmed by birefringence

**Table IV:** Effect of film speed, bath and stock temperatures

| Film speed, ft./min. | 100 | | | | |
|---|---|---|---|---|---|
| Stock temp., °F. | 500 | 500 | 550 | 550 | 550 |
| Water bath temp., °F. | 80 | 110 | 68 | 80 | 110 |
| Haze, % | 6.8 | 6.4 | 4.3 | 4.0 | 3.9 |
| MD[d] % | >100 | 92 | >100 | 62 | >100 |
| Gloss | | | | | |
| TD[c], % | 83 | 78 | >100 | 54 | 95 |
| Eye chart clarity | 4 | 10 | 11 | 10 | 9 |
| Impact strength, ft./lb. | 0.36 | 0.34 | 0.43 | 0.44 | 0.24 |
| Tear strength, g./mil. TD | — | — | — | 1094 | — |
| MD | 7.4 | 7.5 | 12.6 | 8.7 | 8.1 |
| Stiffness, g. | 26.5 | 24.5 | 28.5 | 32 | 28 |
| Coefficient of friction | 0.43 | 0.43 | 0.56 | 0.46 | 0.55 |

[a]At 3/16 to ¼ in. air gap using Resin B. [b]Localized boiling on film. [c]Sixty-degree gloss was measured by an attachment to the hazemeter. A dull crocus cloth background was used to eliminate effects of reflection from this surface. Initial gloss measurements were up to 100. Instrument was recalibrated so that gloss standard of 94 is brought to 70.5, thus permitting maximum gloss reading of 133. [d]MD = Machine direction; TD = transverse direction.

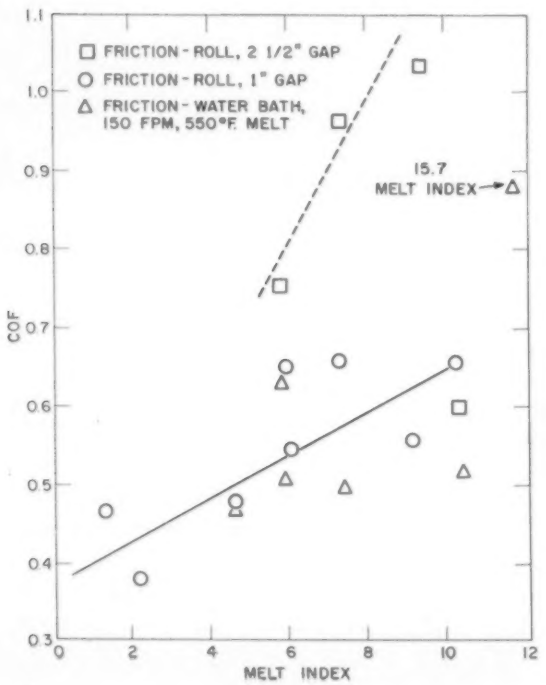



**FIG. 7:** Film coefficient of friction expressed as a function of resin melt index.

on properties of films extruded into water bath.[a]

| | | | | | | 150 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | 500 | 500 | 500 | 550 | 550 | 550 | 550 | 575 | 575[b] | 575[b] | 595 |
| 69 | 80 | 110 | 150[b] | 75 | 80 | 110 | 130 | 84 | 104 | 115 | 79 |
| 6.7 | 7.5 | 7.2 | 7.5 | 5.0 | 5.3 | 5.6 | 5.0 | 3.7 | 3.7 | 3.9 | 2.8 |
| — | — | 91 | 98 | >100 | 63 | >100 | >100 | >100 | >100 | >100 | >100 |
| — | — | 76 | 67 | 88 | 39 | 86 | 86 | 76 | 92 | 98 | >100 |
| — | — | 8 | 8 | 11 | 9 | 8 | 7 | 9 | 9 | 11 | 10 |
| 0.29 | 0.22 | 0.19 | 0.22 | 0.32 | 0.59 | 0.25 | 0.18 | 0.30 | 0.30 | 0.23 | 0.56 |
| — | — | — | — | — | — | — | — | — | — | — | — |
| 10.7 | 6.1 | 4.3 | 6.5 | 8.6 | 8.3 | 7.4 | 12.3 | 9 | 8.8 | 10.3 | 10.4 |
| 22 | 25.5 | 23 | 35.5 | 28 | 30.2 | 30.4 | 32.5 | 25 | 36 | 26 5 | 35 |
| 0.48 | 0.45 | 0.40 | 0.48 | 0.50 | 0.55 | 0.47 | 0.55 | 0.40 | 0.54 | 0.50 | 0.45 |

[a]At 3/16 to ¼ in. air gap using Resin B. [b]Localized boiling on film.

values which were found to be lower at larger air gaps, indicating less directional orientation.

Two interactions were noted from the birefringence data collected in the full factorial experiment run on Resin A. First, a significant decrease in orientation was observed as air gap was increased at the higher chill roll temperature of 110° F.; however, when using the lower chill roll temperature of 80° F., a much lesser decrease in orientation was observed as gap size was increased. Second, increasing film speed produced a larger amount of orientation in the chill roll film when using the lower quench temperature of 80° F. and a 1-in. gap. Increased film speed produced a negligible effect on orientation when a 2½-in. air gap was used.

When operating at the lower stock temperature of 500° F. using an 80° F. chill roll, the effect of increasing air gap on tear strength transverse to the take-off direction was found to be negligible, and it appears that air gap spacing is more important in this property at higher stock temperatures and quench temperatures. A large decrease in transverse tear strength was present at 500° F. as quench temperatures increased to 110° F.

This effect was also found at higher stock temperatures of 550° F. Using an 80° F. chill roll temperature, transverse tear strengths decreased greatly for Resin A films, and also with Resin B, although to a **(To page 179)**

**Table V:** Suggested operating condition for Escon polypropylene film extrusion

| | |
|---|---|
| Die temperature | 540 to 570° F. |
| Adapter temperature | 540 to 570° F. |
| Cylinder temperature | |
| Front | 540 to 570° F. |
| Middle | 480 to 510° F. |
| Rear | 430 to 450° F. |
| Stock temperature | 540 to 570° F. |
| Quench temperature | 70 to 100° F. (Chill roll) |
| | 60 to 100° F. (Water bath) |
| Air gap | ½ to 4 in. (Chill roll) |
| | 1/16 to ⅜ in. (Water bath) |
| Die blade opening | 15 to 20 mils |
| Adapter pressure | 1500 to 4000 p.s.i. |

**Table VI:** Typical flat film properties

| *Property* | *Value* |
|---|---|
| Resin density | 0.90 g./cc. |
| Yield | 31,000 sq. in./lb. |
| Tensile strength | 5,000 to 10,000 p.s.i. M.D. |
| | 3,000 to 5,000 p.s.i. T.D. |
| Elongation | 250 to 400% M.D. |
| | 400 to 600% T.D. |
| Tear strength (Elmendorf) | 25 to 50 M.D. |
| | 80 to 1000 T.D. |
| Impact strength | 0.5 to 2.0 ft. lb./mil |
| Coefficient of friction | 0.3 to 1.0 |
| Haze | 0 to 4% |
| Gloss | 95 to 140 |
| Moisture vapor | 0.40 to 0.60 |
| Transmission | g./100 in.²/24 hr./mil |
| Oxygen transmission | 100 to 200 |
| | cc./100 in.²/24 hr./mil |
| Carbon dioxide | 280 to 600 |
| Transmission | cc./100 in.²/24 hr./mil |
| Oil resistance | |
| (10W30 motor oil/28 days/150° F.) | 3.5 to 7 wt. % increase |

# Fluidized bed coating with vinyl

***How processing variables affect coating thickness***

***and resin fusion in a technique that only looks simple***

**By R. J. Borsh***

Powdered plastics as coating materials have been known to the coatings industry for many years. More recently, however, Edwin Gemmer of Knapsack Griesham A.G., Germany, devised a method for coating preheated substrates with powdered plastics using the fluidized bed technique. His work is described in United States Patent 2,844,489.

The process uses a dry, finely-divided solid as the coating material. The powdery solid is fluidized by passing a current of air or gas through the porous plate of a specially designed fluidizing tank. When properly suspended, the powders resemble a boiling liquid. Articles to be coated are preheated to a temperature above the melting point of the coating material. They are then lowered into the fluidized bed of resin. As the particles of resin contact the hot substrate, they adhere and begin to flow together to form a smooth continuous coating. The substrate, upon removal from the bed, is returned to the oven for further heating in order to complete fusion and flow and to obtain the best possible properties as well as the surface appearance of the coating material.

At first glance, this seems a simple process. But the apparent simplicity can be misleading. Desirable coatings are obtained only under carefully controlled operating conditions.

The fluidized bed coating process offers many advantages over the liquid coating systems: 1) 100% solids suffer no loss of material due to solvent evaporation or overspray; 2) the powders possess excellent storage stability and present no viscosity problems while in use; 3) smooth, continuous coatings can be applied over sharp edges or onto irregularly shaped surfaces. In addition, resins such as polyethylene and polypropylene which are difficult to apply from solution can be applied by this technique.

*Development Engineer, Union Carbide Plastics Co., Div. of Union Carbide Corp., Bound Brook, N. J.

The process also has disadvantages. The coating material must be in a dry powdery form and of a fluidizable nature. In many instances, this is obtained only by expensive pulverizing techniques. Continuous coatings less than 0.005-in. thick are difficult to apply. Like other coating systems, fluidized bed coating materials must be carefully formulated.

### Powder preparation

Many types of thermoplastic and thermosetting resin materials are suitable for fluidized bed coatings; but, because of expense and other contributing factors, many of these will be limited to specialty applications.

Vinyl homopolymer and copolymer resins, however, are low-cost resins and are expected to enjoy wide application as a coating material using this new process. In addition, vinyl coatings are visually attractive and offer excellent chemical and corrosion resistance. A range of plasticizer levels permits great latitude in modifying the hardness and flexibility of the coatings.

Vinyl powders for the fluidized bed coating process may be prepared by either of two methods: 1) pulverizing compounded material and 2) dry blending. The pulverizing of compounded material offers certain formulating advantages. For example, the film forming properties of these vinyl powders are not as sensitive to additions of either pigments or fillers as are most of the dry blended formulations.

Pulverizing finished vinyl compounds, however, requires expensive equipment, considerable handling and, consequently, powders made by this process are more costly to generate than dry blended formulations.

Using the compounding technique, the pigments and stabilizers are first dispersed in the plasticizer. This mix is then incorporated with the unplasticized resin and fed to a mill where it is plasticated, compounded, and finely diced. The diced material must then undergo a micro-pulverizing step. Since the pulverizing step generates considerable heat, sufficient to melt the vinyl, refrigeration must be used. A final screening follows to provide the desired particle size range for powder coating application.

Dry blended vinyl powder coating materials are formulated with special dry blending resins. These

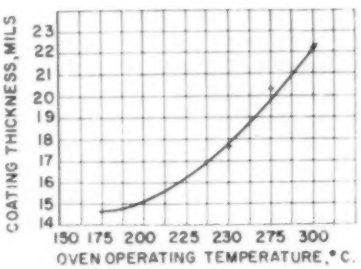



**FIG. 1:** Coating thickness versus the operating temperature of substrate.

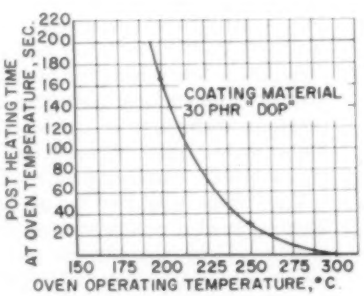
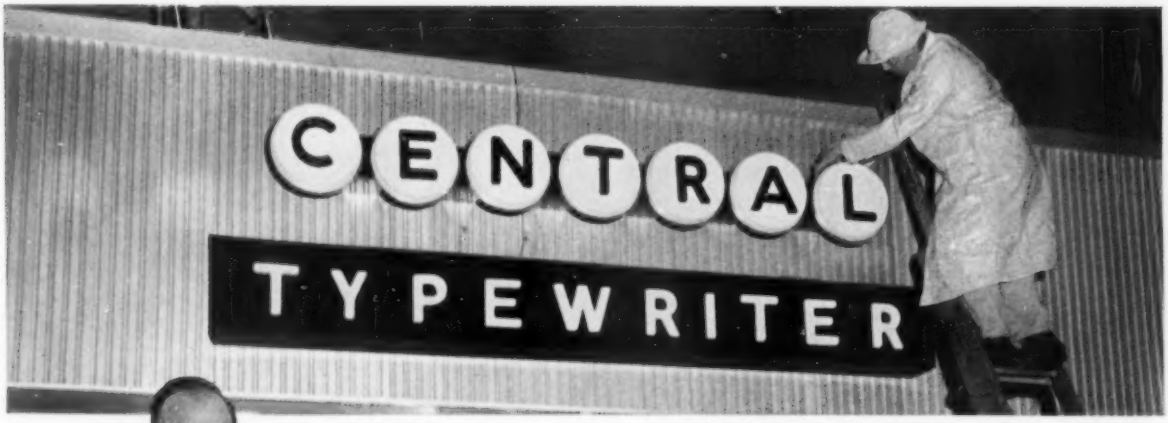



**FIG. 2:** Post heating time versus the operating temperature of substrate.



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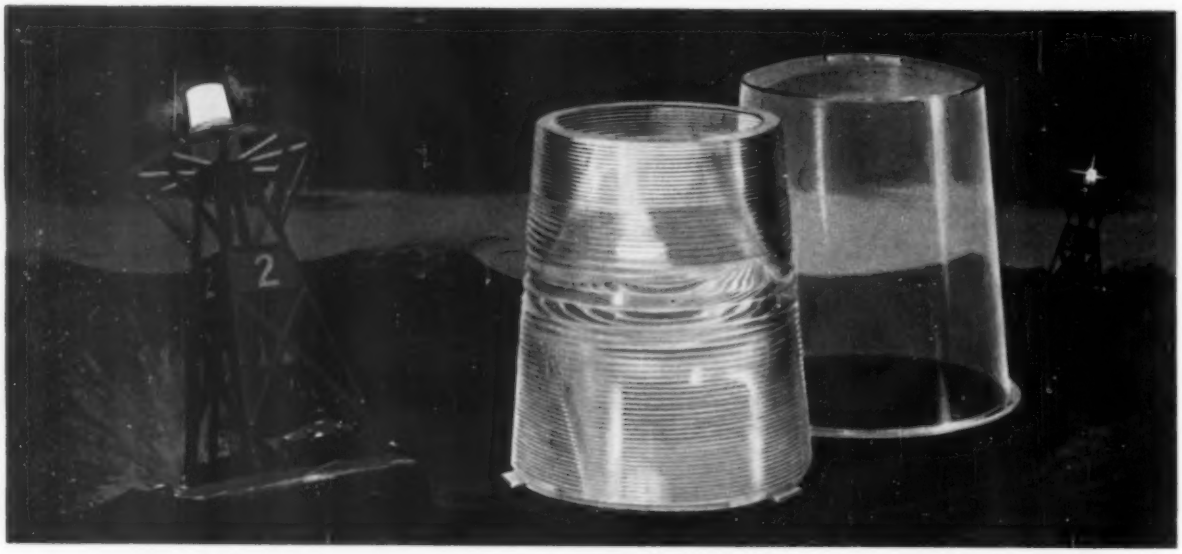

# Handsome and Hardworking
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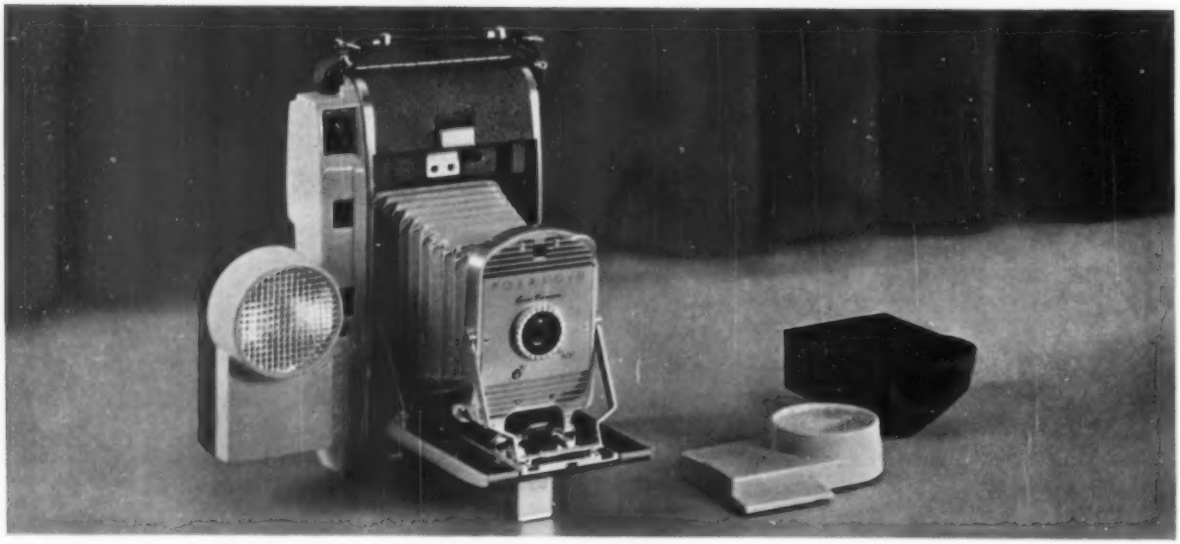

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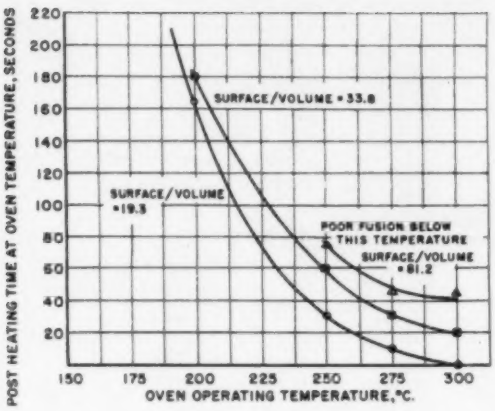



**FIG. 3:** Substrate surface/volume effect on post heating time.

resins must possess two major characteristics. These are:

1. Ability to absorb plasticizer in order to form a dry, free-flowing powder.

2. Ability to flow into smooth continuous coating on contact with the hot substrate.

Some resins need only to absorb as little as 5 p.h.r.[a] of plasticizer to exhibit satisfactory flow characteristics while others, although capable of absorbing as much as 60 to 100 p.h.r., merely degrade when they come in contact with the hot substrate.

Vinyl powder materials are dry-blended in steam jacketed blenders. The stabilizers and pigments are first dispersed in the plasticizer which is then preheated to 60°C. This is added to the resin and mixed in the heated blender. Continuous mixing with the application of heat produces a dry, free flowing powder. The powder is cooled and then screened to remove any agglomerates formed during the dry blending operation. Since equipment and handling costs are reduced to a minimum, dry blended powders can be generated in a more economical manner than the compounded and pulverized formulations.

Unlike compounded and pulverized formulations, dry blended formulations for powder coating applications are very sensitive to small additions of modifiers to the mix. For instance, addition of as little as 0.25 p.h.r. of a finely-ground calcium carbonate will inhibit flow and cause pinholes in the final coating. Although these fillers promote the drying of a blend, they have a tendency to selectively absorb plasticizer and leave the resin insufficiently plasticized. On the other hand, small additions of lubricants, charged to the blend at the end of the dry blending cycle, promote fusion and flow of the coating material. At the same time dryness of the blend is improved. However, compatibility becomes a problem where lubricants are added in quantities greater than 3 p.h.r. in that they exude from the coating.

Increased plasticizer concentration in vinyl formulations improves fusion and flow characteristics of the coating material. However, dry blending resins reach a limit of plasticizer absorption. This will vary according to the individual resin. Further addition of plasticizer will produce a sticky blend which fluidizes poorly and tends to cake in storage. Compounded formulations of high plasticizer concentration are difficult to micropulverize.

### Experimental procedures

Efforts at the Union Carbide Plastics Co. Development Laboratory have been concerned with the study of vinyl resins which can be used to produce fluidized bed coating compounds by the dry blend technique.

Studies were conducted with dry blended formulations based on experimental dry blending resins to determine the relationship of the following parameters in the fluidized bed coating process:

1. Operating temperature.
2. Surface/volume ratio of the substrate to be coated.
3. Post-heating cycle.
4. Plasticizer concentration of the coating material.

Dry blended formulations varying only in plasticizer concentration were prepared in a jacketed Hobart mixer. Plasticizer concentrations were 5, 10, 20, and 30 p.h.r. Three sizes of aluminum panels differing in surface/volume ratio were coated using the fluidized bed coating technique. Coatings were applied by a single 5-sec. dip into the fluidized material. When there is insufficient residual heat in the panel to completely fuse the resin adhering during the dip, the dipped part comes out of the fluidized bed with a "frosty" appearance. In these cases the panels were returned to the oven to promote fusion and surface appearance when necessary, and then water quenched to promote smoothness of the final coatings.

### Oven operating temperatures

The oven operating temperature refers to the temperature setting on the controller of the oven. Since only one oven was used in this investigation, preheating and post-heating of any given panel was conducted at the same oven operating temperature.

The minimum oven operating temperature requirements for the dry blended formulations ranged from 175° C. for the highest plasticized dry blend (30 p.h.r.) to 300°

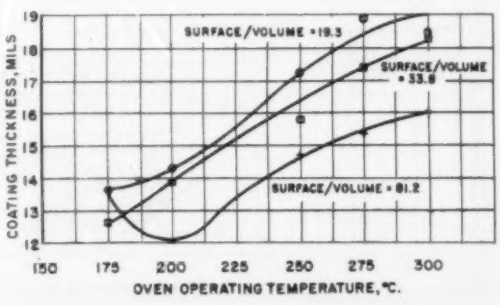



**FIG. 4:** Substrate surface/volume effect on coating thickness.

[a]Parts per 100 parts of resin.

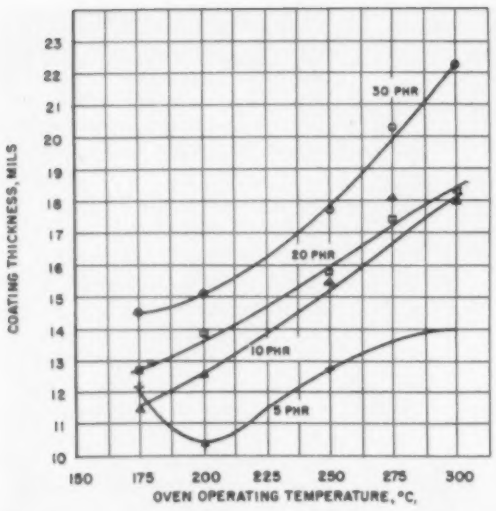



**FIG. 5:** Effect of plasticizer concentration on coating thickness.

C. for the lowest plasticized dry blend (5 p.h.r.). Figure 1, p. 124, shows the influence of operating temperature on the coating thickness as the temperature is increased from 175 to 300° C. The coatings tested were applied to a 1- by 4- by 0.064-in. aluminum panel using a 20 p.h.r.-DOP blend (di-2-ethyl hexyl phthalate) dry blend. The coating thickness of the 20 p.h.r. DOP blend can be increased approximately 43% by increasing the operating temperature from 175 to 300° C.

An increase in operating temperature also decreases the required post-heating time and in some instances completely eliminates this step. Figure 2, p. 124, shows the relationship between operating temperature and post-fusion time. The 30 p.h.r. DOP dry blend used here was applied to an aluminum panel whose surface/volume ratio was 17.6. At 300° C. this panel had sufficient residual heat to fuse and flow the resin pick-up and thus eliminate the post-fusion cycles. The coating thickness on this particular panel was 24 mils.

From the standpoint of general appearance, it was observed that high operating temperatures and short post-fusion time are most desirable. Coatings prepared under these conditions display improved smoothness, uniformity and fusion. However, good heat control is imperative at all times. Overheating may lead to degradation of the coating material, excessive coating build-up and porosity. Non-uniform heating causes uneven film thickness and sometimes results in poor fusion and flow of the powder material.

### Surface/volume ratio of substrates

The surface/volume ratio is expressed in reciprocal inches. It is determined by dividing the total surface area of the substrate by the total volume. For instance, a 1-in. cube would have a total surface area of 6 sq. in. and a surface/volume ratio of 6 $in.^{-1}$. If this cube were cut in half, the volume remains 1 cubic in., while the total surface area increases to 8 sq. in. and the surface/volume ratio to 8 $in.^{-1}$.

Total mass and volume remain constant. Therefore, the heat content of any such square above a reference temperature remains the same. However, with the surface to volume ratio now increased, the amount of heat which is available to be transmitted through a unit of surface has now decreased. For example, assume the heat content of the uncut cube above a reference point was 100 B.t.u. Uncut, the cube's heat transfer density would be 100 B.t.u. per 6 sq. in. of surface or about 16 B.t.u./sq. in. When cut into 2 pieces, the 100 B.t.u. heat content of the cube will now be distributed across 8 sq. in. and the heat transfer density decreases to about 12 B.t.u./sq. in. Note that the heat transfer density is inversely proportioned to the surface to volume ratio, that is, as the surface/volume ratio decreases, heat transfer density increases, resulting in better resin pick-up by the cube.

The effects of surface/volume ratio on post-fusion time and coating thickness were determined from coatings that were applied to aluminum substrates of the following dimensions:

| *Panel dimensions* | *Surface/volume ratio* |
|---|---|
| in. | $in.^{-1}$ |
| 2 by 4 by 0.124 | 17.6 |
| 1 by 4 by 0.064 | 33.8 |
| 3 by 6 by 0.025 | 81.0 |

As would be expected, substrates of low surface/volume ratio require less post-heating time than those of higher surface/volume ratio, as shown in Fig. 3, p. 127. It is also shown that post-heating can be eliminated, provided the residual heat which varies with the above surface/volume ratios is sufficient to fuse and flow the resin pick-up.

The resin pick-up and ultimate coating thickness also become heavier as the surface/volume ratio decreases. Figure 4, p. 127, shows the variation in coating thickness when substrates of different surface/ **(To page 186)**

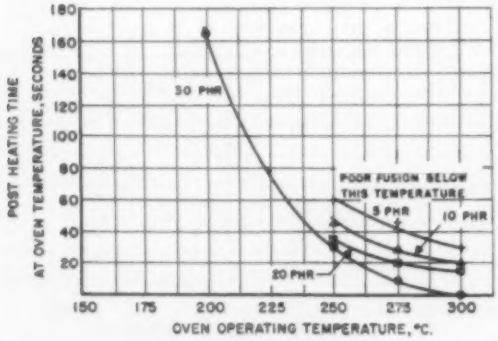
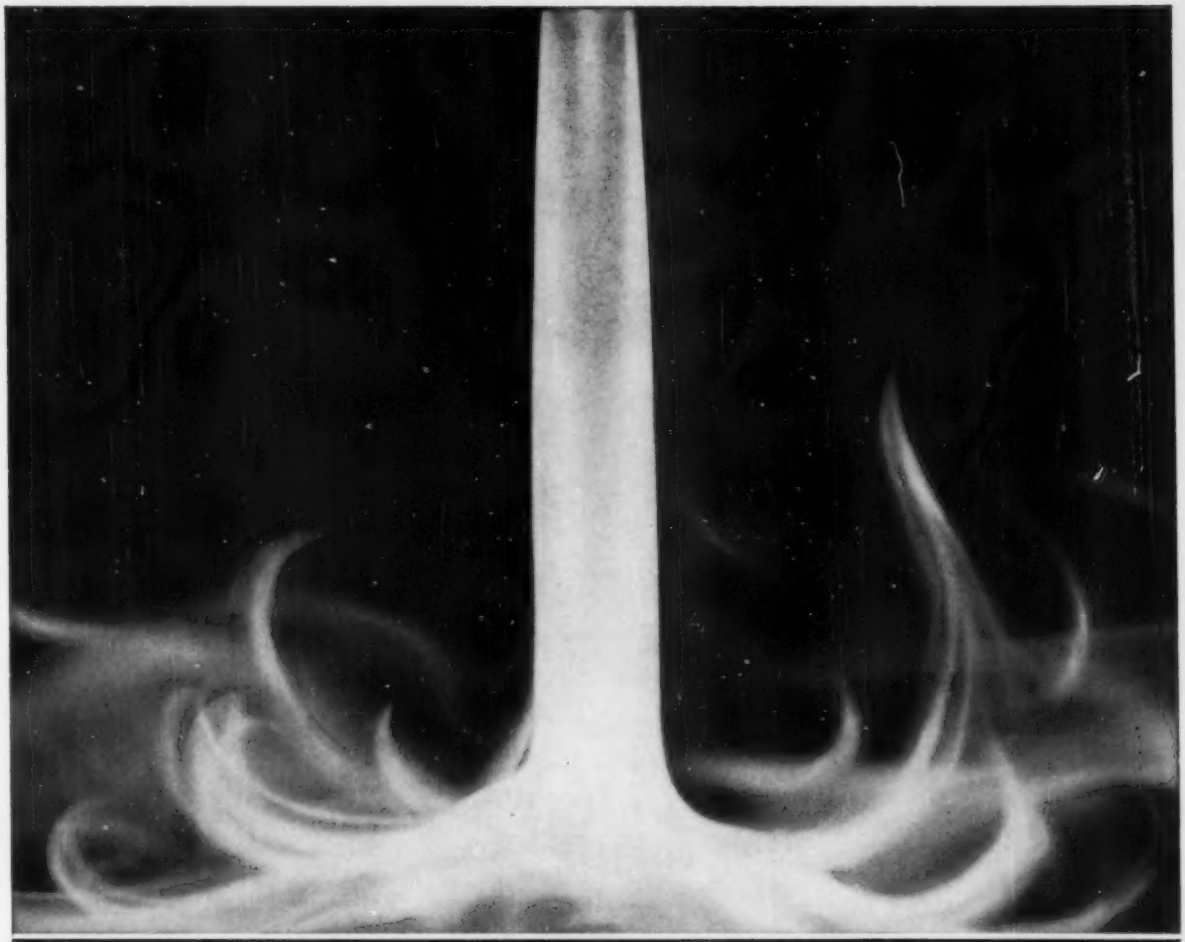



**FIG. 6:** Effect of plasticizer concentration on post heating time.



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|---|---|---|---|
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| Chlorowax 70 | (parts by weight) | — | 12.5 |
| Antimony Trioxide | (parts by weight) | — | 12.5 |
| Luperco ATC | (parts by weight) | 2.0 | 2.0 |
| 3 oz. Glass Mat | (parts by weight) | 60.0 | 60.0 |
| Flexural strength psi (dry) | | 26,400 | 27,500 |
| Flexural strength psi (wet) | | 24,000 | 25,000 |
| Tensile strength psi (dry) | | 15,000 | 15,700 |
| Tensile strength psi (wet) | | 14,000 | 14,300 |
| Flame-out (seconds) | | Burns | 1 |
| **POLYETHYLENE SYSTEM*** | | | |
| Polyethylene Resin | (parts by weight) | 100.0 | 85.0 — 63.0 |
| Chlorowax 70 | (parts by weight) | — | 7.5 — 18.5 |
| Antimony Trioxide | (parts by weight) | — | 7.5 — 18.5 |
| Antioxidant | (parts by weight) | .5 | .5 |
| Tensile strength (psi) | | 1,800 | 1,650—1,500 |
| % elongation | | 600 | 590— 200 |
| Flammability | | Burns | Self-extinguishing |

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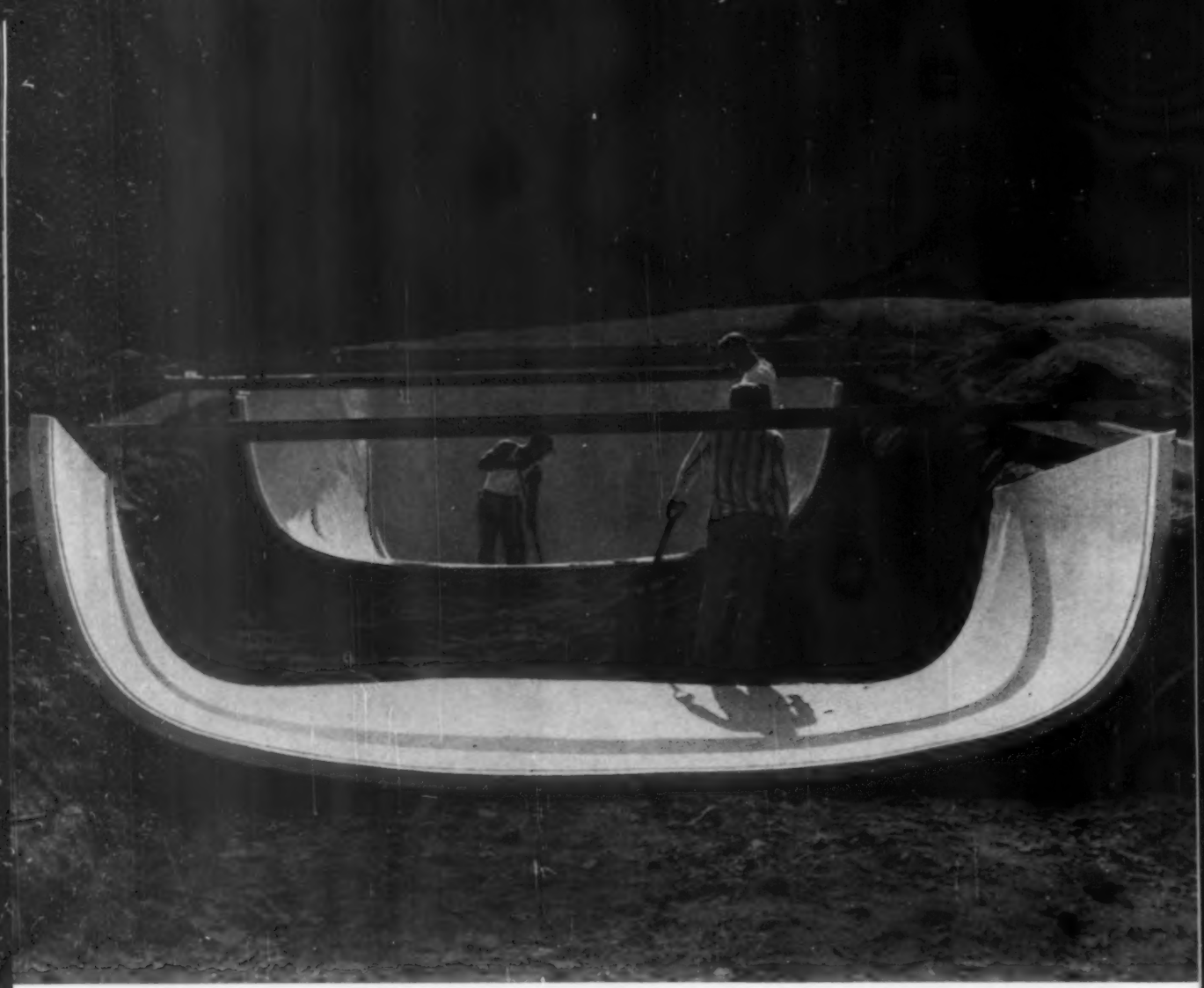

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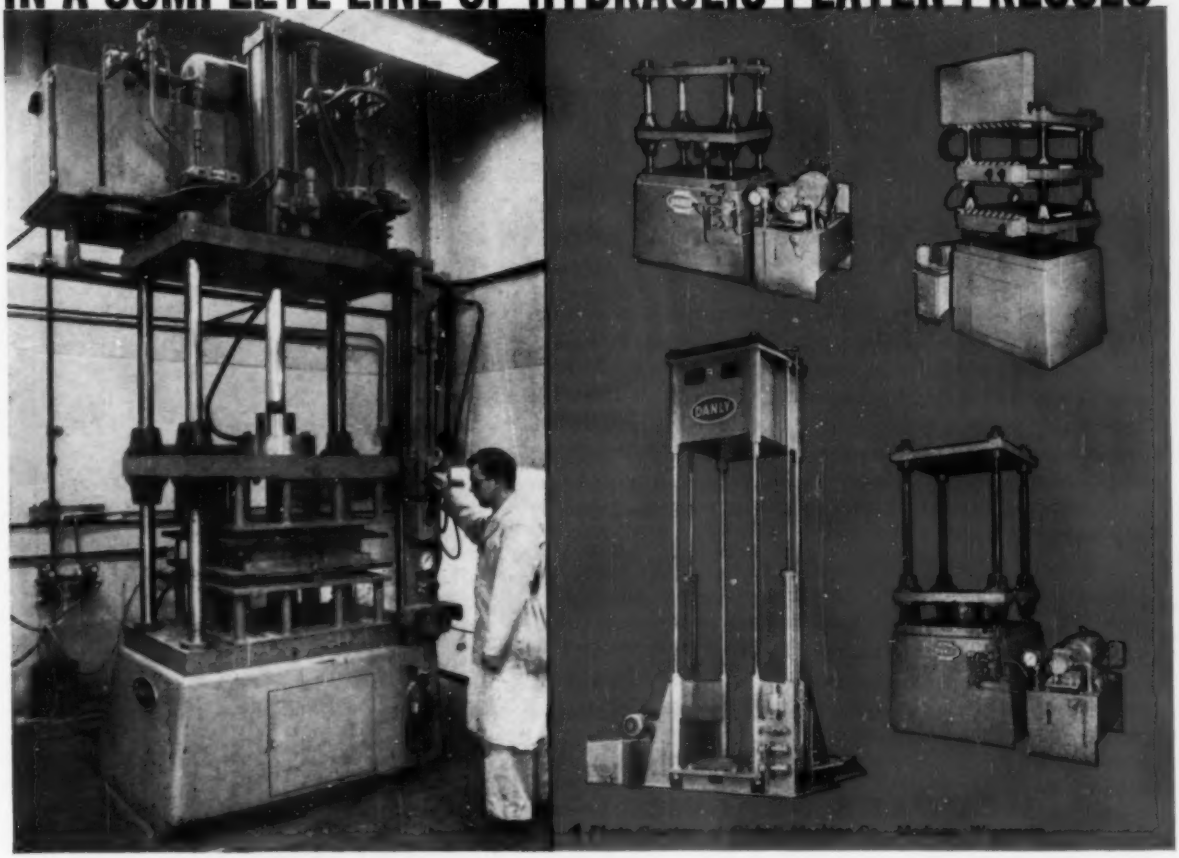


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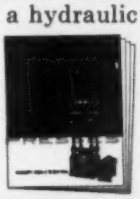

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# POLYMERIC MELTS

## . . . a study of steady-state flow, extrudate irregularities, and normal stresses

By A. B. Metzner†, E. Lucille Carley‡, and I. K. Park§

This paper reports on the steady-state flow properties of molten polymers and the effects of pressure on these properties, the occurrence of irregularities in extrudates, and the calculation of normal (elastic) stresses from measurement of extrudate diameters. The measurements of the steady-state flow properties emphasize the importance of the use of long tubes or suitable corrections for inlet effects. Additionally, the expected small changes in the viscosity of polyethylene with pressure are confirmed up to pressures as high as 19,000 p.s.i. Contrary reports in the published literature are discussed and shown to be largely due to unreliable data or to incorrect interpretation of the data.

The importance of the tube entry in causing irregularities in the extrudate, suggested by earlier studies, has been confirmed by experiments carried out in an "infinite" tube. However, the effects of changing the geometry of the inlet of a tube on the occurrence of irregularities in the extrudate, while significant, are seen to be much less than reported in earlier papers in which extremely short tubes were used. It is shown that an appreciable increase in the critical stress at which irregularities are incipient is obtainable through the use of long dies.

Calculation of the normal stresses in flowing melts confirms the expected greater elasticity of polypropylene over polyethylene. These results enable the calculation of the maximum pressures obtainable in a "centripetal pump" or "screwless extruder," for example. However, this part of the study must as yet be considered to be indicative rather than confirmatory as much further work is required in this area.

The behavior of molten polymeric materials when passing through cylindrical dies has been the subject of a number of studies (1, 3, 9, 16-22)[1] because of the interest in this technique from a processing viewpoint as well as its utility for obtaining the physical properties of the material and studying the irregularities that occur at the higher extrusion rates. With respect to the latter two aspects, however, the available studies are of somewhat limited value in view of the use of very short dies or tubes, frequently termed "orifices." Bagley (1) has shown that under some conditions the pressure loss at the entrance is largely confined to a very short region, but this does not rule out the presence of other, more subtle yet important, effects that may continue for a much greater distance along the tube. In fact, the present work will show that inlet effects may continue to influence certain results until a length to diameter (L/D) ratio of greater than 130 is employed. This is hardly surprising and most problems in fluid mechanics have been studied in tubes of at least this L/D. However, the highly viscous nature of most polymeric melts makes experimental work employing such long tubes inconvenient, and most studies have been in very short tubes. While Clegg (3) studied flow through tubes with L/D ratios of 32 and 24, as well as shorter tubes, Severs (16) and Spencer and Dillon (17) each used only one tube with an L/D above 20 and all of the numerous other authors (1, 18-20, 22) restricted their studies to tubes having L/D ratios of 20 or less. Similarly, effects in the entrance

[1] Numbers in parentheses denote references at end of article, p. 187.

* Reg. U. S. Pat. Off.

† Associate Prof., Dept. of Chemical Engineering, University of Delaware, Newark, Del.
‡ Process Developments Inc., Philadelphia, Pa.
§ Dept. of Chemical Engineering, Princeton University, Princeton, N. J.

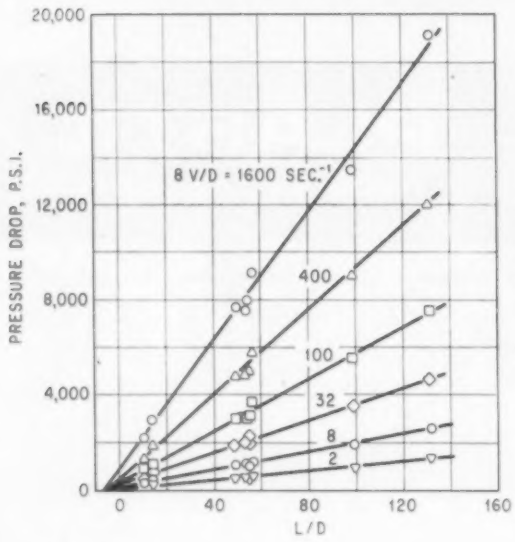



**FIG. 1:** Dependence of pressure drop on tube length (evaluation of end effect) for polyethylene at 160° C., using tubes that have sharp-edged entrance regions.

regions of dies have long been suggested to be of importance, but until the recent data of Clegg (3) were published study of only the single conical entrance reported by Tordella (19) was available. These comments should not be construed to indicate that the studies to date have not been enormously useful, as they have established a large number of facts unequivocally, such as the temperature and tube diameter independence of the critical shearing stress at which irregularities may first be observed in an extrudate. However, it is obvious that many effects remain to be investigated.

The purposes of the present study were, as suggested above, to determine the relative effects of die length, inlet geometry and, incidentally, of pressure, upon the flow of molten polymers. Additionally, this paper reports the determination of normal stresses in flowing polymeric melts. These arise out of the elasticity of the material; they have been believed to be at least related (and possibly to be responsible) for the irregularities observed at high extrusion rates, and are responsible for the operability of the Reiner centripetal pump (14) which has recently been applied to molten polymers (6). Polymers of both ethylene and propylene have been used in the present work.

**Table I:** Diameters and length-diameter ratios of capillary tubes

| *Tube* | *Diameter* | *L/D* |
|---|---|---|
| | in. | |
| 1 | 0.0901 | 53.8 |
| 2 | 0.0576 | 54.8 |
| 3 | 0.0471 | 99.0 |
| 4 | 0.0471 | 49.7 |
| 5 | 0.0471 | 10.5 |
| 6 | 0.0234 | 132.0 |
| 7 | 0.0234 | 56.5 |
| 8 | 0.0234 | 13.7 |
| 9 | 0.0576 | 35.0 |
| 10 | 0.0576 | 17.5 |
| 11 | 0.0576 | 8.7 |
| 12 | 0.0225 | 133.1 |
| 13 | 0.0225 | 200.0 |

### Apparatus and materials

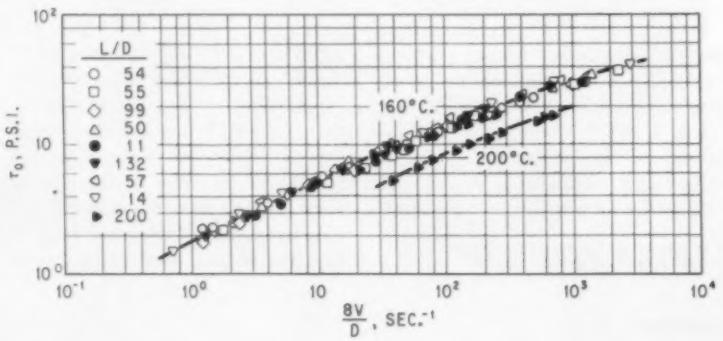
The apparatus consisted of a capillary-tube viscometer (sometimes called an extrusion rheometer). Pressured ethylene glycol, compressed in a French pressure cell placed in a Universal Testing Machine, was used to supply constant-pressure driving forces. The region downstream from the capillary-tube exit was surrounded with an electric heater to avoid temperature changes in the emerging extrudate; the material chamber and capillary tube were immersed in a constant temperature bath. The diameters and length-diameter ratios of the capillary tubes used in this investigation are given in Table I, below. A sharp-edged (180°) entry to the capillary tube, as well as smooth conical entries with included angles of 20, 40, 85, and 160° were studied. Details of the apparatus are available elsewhere (2, 11).

Two fluids were studied: 1) low-density polyethylene (specific gravity 0.92 at 25° C., 0.78 at 160° C.) having a molecular weight of 18,000 and a flow temperature of 100° C., manufactured by E. I. du Pont de Nemours & Co. Inc., and 2) polypropylenes having molecular weights of 125,000, 210,000, and 300,000, and specific gravities of 0.77 at 190° C. and 0.75 at 230° C., manufactured by the AviSun Corp. The material with a molecular weight of 300,000 had melt indexes of 1.7 g./10 min. at 230° and 0.25 g./10 min. at 190° C.

### Steady-state flow properties

It has already been shown 1) that the classical empirical method of correcting for end effects experimentally by plotting pressure drop versus the L/D of the tube, at various flowrates or shear rates, yields very good straight lines over the range of L/D values between 0 and 15 for polyethylene melts when sharp-edged (180°) entrances to the tubes are used. Figure 1, above, shows typical supporting data over a 10-fold range of L/D values which, with one exception, are all higher than those reported by Bagley. The straight lines shown were in all cases fitted by the method of least squares. The resulting composite shear stress, 8 V/D curve, for all tube lengths studied, is shown in Fig. 2, below. It should be noted that the end effects of Fig. 1 are equivalent to L/D ratios of from 3 to 6, de-

**FIG. 2:** Composite flow curve for PE at 160° C. and flow curve at 200° C.



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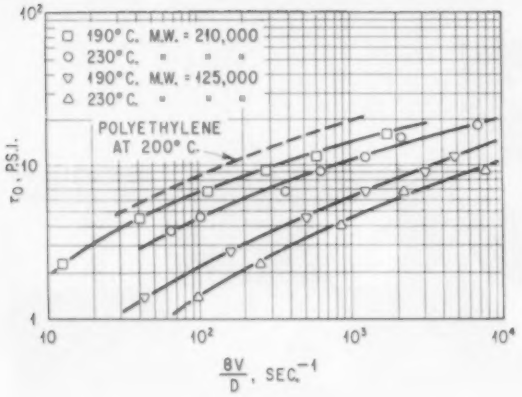


**FIG. 3:** Flow curves for polypropylene taken in a tube having an L/D ratio of 54.8.

pending on the shear rate used. Obviously, if one were to use a tube with an L/D of as little as 10, for example, from 20 to 40% of the total pressure drop would be due to entrance effects, the exact percentage changing with shear rate or 8V/D. It is clearly evident that of the tabulated data recently compiled (21) on a variety of polymeric materials, some are only of little better than qualitative value where short tubes were used and no end corrections were applied.

The absence of any systematic deviation of the data at the highest pressures in Fig. 1 is proof that the changes in viscosity with pressure were negligibly small over the range of pressures studied, up to 19,000 p.s.i., for this material and temperature. This constitutes limited proof of an earlier suggestion (8) that a report to the contrary (5) was due to confusion of pressure effects with those of shear rate. In a recent paper Westover (20) has clearly separated shear rate effects from those of pressure alone, but he still found large effects of pressure. However, the data obtained using tubes of various diameters scatter greatly instead of giving the perfect agreement required by theory and observed in the present study as well as by many prior workers. As a result their validity and the conclusions drawn are both open to serious question except under conditions where the effects are unusually large,—for example, when crystallization was believed to be induced at the lower temperatures. It should be noted that the test for pressure effects given by Fig. 1 is a very sensitive one, so that, although the data presented here are limited in quantity, they are entirely conclusive insofar as the particular temperature and material are concerned; further confirmatory data were obtained at other temperatures and with other inlet geometries.

Capillary tube data, similar to those of Fig. 2, were also obtained when the transition from the ¾-in. material-chamber diameter to that of the capillary tube was not abrupt but instead consisted of a conical region. Data using such conical entries with included angles of 20 to 160° and three L/D ratios of the tubes 8.7, 17.5, and 35.0) showed results substantially identical to those of Figs. 1 and 2. Thus it appears that the type of entrance used has no significant effect on the measurement of steady flow properties and at most only a minor effect on the magnitude of the end correction.

**Table II:** Effect of entrance geometry on development of irregular PE extrudates

| *L/D of tube* | *Included cone angle* | *Critical value[a] of 8V/D* |
|---|---|---|
| | *degrees* | *sec.$^{-1}$* |
| 35 | 180 | 45-90 |
| | 160 | 90 |
| | 85 | 80 |
| | 40 | 100 |
| | 20 | 280 |
| 17.5 | 160 | 70 |
| | 85 | 50 |
| | 40 | 90 |
| | 20 | 300 |
| 8.7 | 160 | 100 |
| | 85 | 80 |
| | 40 | 80 |
| | 20 | 270 |

[a] 8V/D values correspond to a temperature of 160° C. Values of the critical stress have generally been found to be independent of temperature. Thus, critical values of 8V/D may be obtained at other temperatures by reference to flow data at several temperatures, such as are shown in Figs. 2 and 3. The critical values of 8V/D are probably no better than ±20 percent.

Polypropylene flow curves are given in Fig. 3, left, at two temperatures. Although no end correction was made, it should be noted that end corrections such as those of Fig. 1 would be insignificant at L/D ratios as large as those used in obtaining the data of Fig. 3. Insofar as the steady flow properties at a given temperature level are concerned, low-density PE and PP are very similar. This does not mean that their behavior in commercial extrusion operations will be identical, as factors in addition to their steady flow behavior may be of importance.

### Extrudate irregularities

The occurrence of extrudate irregularities has frequently been traced to the tube inlet although a review of work in this area (9) has pointed out that the available data, while perhaps highly indicative, are inconclusive. The effect of using a conical entry with 20 or 24° included angles has been stated to increase the critical shear rate at which helical irregularities occur by 10 to 14 fold (3, 19), but details are given only by one of the investigators. The fairly extensive data given in Table II, left, show that whereas little or no effect of entrance geometry is observed with included angles ranging between about 40 and 180°, a marked increase in the rate of extrusion is possible when an included angle of only 20° is used. However, in no case is the increase in permissible flowrate as marked as has been reported heretofore. The reason for this probably lies in the use of very short tubes by the prior authors. Tordella (19) has not reported the tube L/D for which the 10 to 14 fold increase in 8V/D was observed, but all of his tubes were fairly short; the L/D of Clegg's (3) tube was only 4.3.

The above suggests that some of the advantages of a conical entry may be obtained by merely using a longer tube having a sharp-edged entry. This would have a number of advantages if it were possible, as a conical entry with an included angle of only 20° occupies a great deal of space in the material chamber upstream

from the tube itself. Table III, right, summarizes supporting data on polyethylene at 160° C. Although the spread in the data is appreciable, the presence of a trend is well-defined.

Returning to Fig. 2 for a moment, one sees that the frequently suggested method of locating the occurrence of incipient roughness by looking for a change in the slope of the curve or for an inflection point is a spurious approach since the curve is obviously a smooth one without any sharp break. (This may also be observed in the data of some of the investigators who have suggested use of such a technique!) Furthermore, the data for various L/D values superimpose, even in the region in which some extrudates from the shorter tubes have become irregular and those from the longer tubes are still smooth.

Although the above results are still not entirely conclusive, they do show that if the extrudate irregularities are not caused by flow in the entrance region to the tube, they are at least strongly influenced by entrance conditions. To show conclusively whether entrance conditions as such are directly responsible for the condition of the extrudate, polyethylene was extruded out of an "infinite" tube which had no entrance region. This was achieved by filling the tube very slowly and then allowing the melt in the capillary tube to "relax" for a sufficiently long time to recover from any stresses imposed during its introduction into the tube. In practice stress relaxation periods of 5 to 18 hr. were used. Obviously, if in these experiments no irregularities were observed in the extrudate under conditions of shear rate (or stress) that normally would have created irregularities, then the entrance region alone must have been responsible for the irregularities. The results obtained were most interesting. For example, in a tube having an L/D ratio of 54.8 with a shear stress of 15.3 p.s.i. ($8V/D$ = 135 $sec.^{-1}$) the normal extrudates had a very pronounced helical pattern and those obtained in the no-entrance region experiments were perfectly smooth. Unfortunately, this experiment becomes increasingly difficult to carry out as the flowrates are increased, since the tube may then empty in less than the length of time required to adjust the system to constant conditions. Thus, while the above data unequivocally point out the importance of the entry for the first time, they do not define the conditions, if any, under which extrudate irregularities would occur on emergence of the melt from an "infinitely" long tube.

**Table III:** Variation of critical $8V/D$ with tube length for polyethylene at 160° C.

| *L/D of tube*[a] | *Critical 8V/D* |
|---|---|
| | *sec.*$^{-1}$ |
| 10 to 20 | 25 to 70 |
| 35 to 55 | 40 to 90 |
| 100 to 135 | 75 to 120 |
| 200 | 160 to 170 |

[a] Tubes had sharp-edged entries and diameters of 0.023 to 0.090 inch.

A study of exit effects was also carried out using flared exits on the tubes through which the extrusion was taking place, in order to determine what effect, if any, this might have on extrudate regularity. These results were generally noninformative.

Clegg (3) has noted that when a conical entry was used to postpone the "spiralling" type of surface behavior or irregularity to higher shear rates, the surface instead became marred with a small-scale roughness. No such behavior was observed in any of the present studies; reasons for the difference in the experimental observations concerning this point may lie in differences in the polyethylene used or, more likely, to the use of a constant pressure extrusion device (rather than a constant rate mechanical unit) and/or longer tubes in the present study.

**Table IV:** Effect of entrance region on swelling of polyethylene extrudate

| *8 V/D* | *L/D of tube* | *Extrudate diameter ratio*[a] |
|---|---|---|
| *sec.*$^{-1}$ | | |
| 11 | 133.1 | 1.027 |
| 11 | 200. | 1.0055 |

[a] Ratio of extrudate diameter to diameter of extrudate obtained from a tube having no entrance region. The data are averages of several determinations.

### Extrudate swelling

Elastic recovery of the extrudate from the stresses imposed on it during flow has long been known to cause the "jet" of extrudate to swell to a diameter greater than that of the tube through which it flowed[2]. Since the elastic recovery must be from stresses imposed during flow into the tube as well as through the tube, it would be expected that the actual extent of the swelling would be strongly dependent upon the L/D ratio of the die or tube. Figure 4, p. 140, depicts typical data that show this effect as a function of $8V/D$ (which, in turn, is directly proportional to the shear rate). As would also be expected, other experiments showed that use of conical entrance regions markedly reduced the swelling observed in the shorter tubes and had a lesser effect on the longer ones.

Figure 4 suggests that at the higher flowrates, an L/D of 133 is sufficient to eliminate effects of the tube entrance itself. To demonstrate conclusively the L/D required to achieve an independence of inlet conditions, the data shown in Table IV, above, were obtained, in which results using the "no entrance region" technique are compared with flow from the usual chamber into a tube having a sharp-edged entrance region. The extrudate diameters obtained with an L/D of 200 were always within 1% of those obtained from the infinite tube and the average, as shown in Table IV, were within 0.55 percent. The 2.7% difference obtained using the tube having an L/D of 133 decreased at higher shear rates, but would be too large to calculate accurate normal stresses at the lower shear rates.

### Elastic (normal) stresses

For all of the processing reasons previously outlined the quantitative measurement of the elastic stresses *under actual flow conditions* is of interest. This in turn implies that oscillatory techniques such as are frequently used in the testing of "solids" may be of little

[2] As a matter of fact, this was observed at least as early as 1893.

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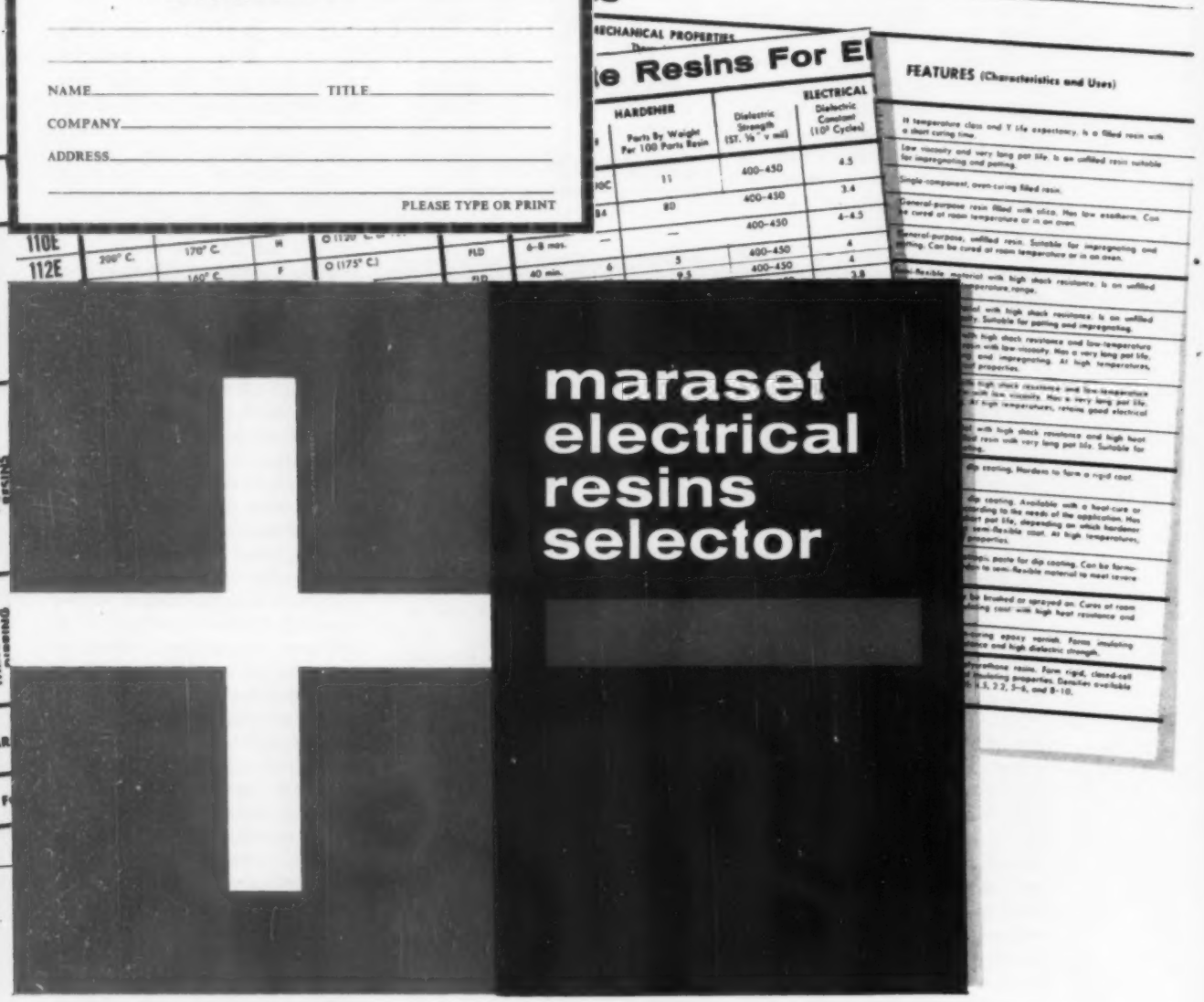


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value unless an all-inclusive theory of proven applicability to polymeric melts is available to predict what may happen within one range of experimental variables from measurements in another.

Three general approaches to measurement of elastic stresses under flow conditions appear to be available. The most obvious would be the conversion of the Roberts rheogoniometer (15), so successfully used with polymeric solutions, into a sufficiently rugged yet sensitive instrument to permit the shearing of melts within the ideal cone-and-plate geometry used. Only one such instrument has been built (13); the range of attainable shear rates was not high. Secondly, measurements of the pressure produced under shut-off conditions in the Reiner centripetal pump may be employed. Thirdly, the expansion of an extrudate jet emerging from a capillary tube may be related to the normal stresses within the fluid. Both of these last geometries suffer from the disadvantage that the shear rates are not perfectly uniform within the sample, hence some theoretical relation must be integrated and an experimental check is available only on the integrated result[3]. Both of the rotational instruments (i.e., the rheogoniometer and the centripetal pump) are restricted to low shear rates unless the material is highly elastic because of the development of appreciable centrifugal forces at the higher rotational speeds. Since the capillary tube experiment does not suffer from this limitation, it was chosen for the present work. Similar experiments have already been described by Philippoff and Gaskins (12) and by Gavis and Gill (4). The latter's mathematical analysis is not applicable to the present problem and that of Philippoff and Gaskins is not believed to be entirely correct.

In the absence of any significant viscous drag of the air on the fluid jet, the only forces acting on it are the elastic and inertial forces of the fluid itself, and gravity. If the latter can be ruled out, as by the use of a short horizontal jet, the total forces to which the jet is subjected in the flow direction are constant. The forces acting on the fluid just before it emerges from the tube are the flux of momentum and the tensile elastic stress, which is opposite in sign to the momentum flux. Both, of course, must be integrated across the radius of the tube. Further downstream in the jet it is assumed that the tensile elastic stresses have been completely recovered, as the shearing stresses causing them have been completely removed, and the only remaining force is that of the flux of momentum in the jet with (now) a uniform velocity at all radii. As the fluid recovers from the elastic stresses, its total momentum decreases and the jet diameter expands.

In order to calculate the variation of the momentum flux with radial position in the tube, the velocity profile must be known. In this work the profile given by the power law (8) has been used since both materials obeyed it sufficiently accurately. However, any of the numerous lengthier equations may be employed without any significant increase in complexity. The velocity profile also describes the radial variation of the shear rate which in turn determines the elastic stresses through an appropriate mathematical relationship. The many normal stress theories proposed have recently been reviewed (7); it has been shown that only those of Oldroyd (10) appear to be general enough to predict all of the important effects (i.e., both normal stresses and the correct non-Newtonian flow behavior under conditions of steady shear) in agreement with experimental observations on polymeric solutions, and yet sufficiently simple to enable determination of the material constants with a finite number of experiments. These equations will be used as a basis for interpretation of present data. The symbols are defined in Table V, below.

The tensile elastic stress in the fluid, under conditions of steady, simple shear, is given (7, 10) as:

$$\tau_{11} = [(A\,\tau_{12}/u') - (B/g_c)]\,(u')^2 \quad \text{Eq. 1}$$

where $u'$ is the shear rate, $\tau_{12}$ the shearing stress, $g_c$ the dimensional conversion factor, and $A$ and $B$ are material constants at the given temperature. Insertion of this equation in the force balance discussed earlier (7) gives upon integration and rearrangement:

$$\left(\frac{D}{d}\right)^2 = \frac{3n+1}{2n-1} - \left[\frac{32\,A\,K'\,g_c}{\rho\,D^2\,(8V/D)}\,1-n - \frac{4\,B\,(3n+1)^2}{\rho\,D^2\,n\,(n+1)}\right] \quad \text{Eq. 2}$$

For simple, non-elastic fluids, $A$

[3] It is frequently suggested that the same difficulty may apply to use of capillary tubes in measurement of steady-flow (viscous) fluid properties, but such a statement is incorrect. In this case interpretation of data is directly possible through use of the Mooney-Rabinowitsch-Weissenberg development (8, 12), but no such treatment of normal stresses has as yet been made.

**Table V:** Definitions of symbols used in this article

| *Symbol* | *Definition* |
|---|---|
| **A, B** — | Elasticity parameters in the Oldroyd equation (Eq. 1). |
| **d** — | Diameter of extrudate. |
| **D** — | Inside diameter of tube or die. |
| $g_c$ — | Dimensional conversion factor: $g_c = 32.2$ (ft.) ($lb._m$)/(sec.$^2$) ($lb._f$). |
| **L** — | Length of tube or die. |
| **K** — | Consistency index in the power law equation: $\tau = K(u')^n$. |
| **K′** — | Consistency index in the round-tube analog of the power law: $\tau_0 = K'\,(8\,V/D)^{n'}$. This equation does *not* require that the fluid obey the power law; however, if it does, $n = n'$ and $K' = K\,(3n+\frac{1}{4}n)^n$. |
| **n, n′** — | Flow behavior indexes defined under K and K′. |
| **u′** — | Shear rate. At the wall of a round tube $u' = (3n' + \frac{1}{4}n')\,(8\,V/D)$ for the fluids considered here, under conditions of steady isothermal flow (7, 8). |
| **V** — | Mean or bulk velocity of fluid passing through a round tube. |
| $\rho$ — | Fluid density. |
| $\tau$ — | Stress. $\tau_{12}$ denotes a shearing stress and $\tau_0$ the shearing stress at a tube wall. $\tau_{11}$ denotes the axial (tensile) elastic stress; $\tau_{22}$ and $\tau_{33}$ denote the normal stresses in the other two co-ordinate directions. For a discussion of the convention concerning subscripts see references 7, 10, or 15. |

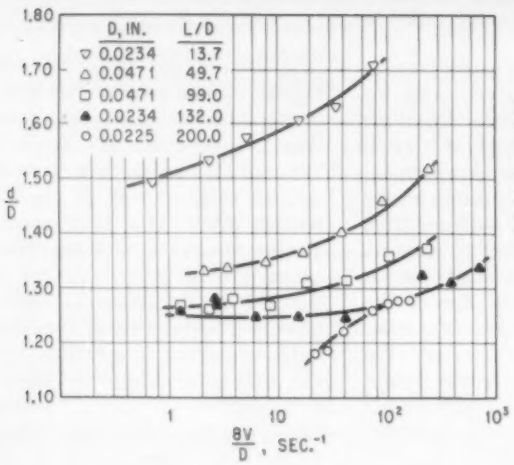



**FIG. 4:** Swelling of polyethylene extrudate at 160° C., sharp-edged entrance regions. Variation of the ratio of the extrudate to the tube diameter with 8 V/D.

and $B$ are both equal to zero and the jet contracts unless $n = 0$, in which case no change in momentum occurs as the material emerges from the tube since the velocity profile is already flat. Thus the term within the square brackets may be considered as a "correction" that determines the degree to which the jet expands from the normal diameter $d$ to which a non-elastic fluid jet would shrink upon emergence from the tube.

Experimentally determined values of d/D for both polyethylene and polypropylene are given in Fig. 5, right. An L/D of 200 was used to ensure the dependence of jet diameter only on flow conditions within the tube and not on the inlet geometry. The lines through the two sets of data points are not necessarily "best fit" curves, but rather represent Eq. 2. The values of $A$ and $B$ determined from these curves are given in Table VI, right. Both are negative and both meet all of the conditions concerning their relative magnitude required by the theory (7, 10).

The fluid jet always expanded under conditions of interest in the present study, i.e., the "B" term of Eqs. 1 and 2 predominates. The characterizing feature of polypropylene is that it has a considerably higher elasticity than does the polyethylene, as would be expected from qualitative observations of its behavior. Therefore, the maximum pressure it could produce in a centripetal pump would be expected to be far higher. Its behavior in a conventional screw extruder would also be markedly different because the alternating nature of stresses to which the polymer is subjected as it moves over the flights of the screw, would be expected to produce different effects in a more highly elastic fluid.

If one adopts Tordella's suggestion (18) that the onset of irregularities in an extrudate depends on the ratio of the elastic to the viscous stresses in the melt, the ratio of $\tau_{11}/\tau_{12}$ would appear to be the most probable critcial parameter[4]. Using Eq. 1 to determine $\tau_{11}$ and the flow curves of Figs. 2 and 3 to obtain $\tau_{12}$, at the "critical" point when irregularities first appear one obtains for polyethylene: $(\tau_{11}/\tau_{12})_{cr} = 2 \times 10^{-6}$ and for polypropylene: $(\tau_{11}/\tau_{12})_{cr} = 300 \times 10^{-6}$. Obviously, a constant value of this dimensionless parameter is not indicated. Similar differences have also appeared in preliminary data at various temperatures for polyethylene, and, of course, the ratio changes with L/D of the tube since the critical shear rate varies with L/D. The source of these difficulties probably lies in the fact that entrance effects, not effects within the tube itself, are responsible for creation of the irregularities as discussed earlier. Within this entrance region the local shearing stresses and shearing rates may be higher than at the wall of the tube under conditions of well-developed flow. In other words, the above evaluation of $\tau_{11}/\tau_{12}$ was simply not carried out at the appropriate point in the system, but as yet there are no methods available for prediction of the stress history of the fluid in the inlet region. Alternatively, one may test for the constancy of the critical ratio $\tau_{11}/\tau_{12}$ at the beginning of irregularities in the "infinite tube" experiment, which is free of inlet effects, but this presents a number of formidable experimental difficulties.

[4] It is not the only possible ratio of normal to viscous stresses, as the normal stresses perpendicular to the flow direction ($\tau_{22}$ or $\tau_{33}$) could have been chosen in place of $\tau_{11}$. However, $\tau_{22}$ and $\tau_{33}$ have normally been found to be smaller than $\tau_{11}$, hence possibly less important.

### Conclusions

1. The importance of end effects in capillary-tube viscometers or dies has been confirmed and extended using tubes of far greater length to diameter ratios than heretofore studied.

2. The expected small dependence of flow properties on pressure, up to pressures as great as 19,000 p.s.i., has been confirmed for polyethylene at 160° C. Reasons for **(To page 187)**

**Table VI:** Numerical values of the Oldroyd normal stress parameters

| *Material and temp.* | *A* sec. | *B* $lb._m/ft.$ |
|---|---|---|
| Polyethylene, 160° C. | $-0.61 \times 10^{-9}$ | $-3.2 \times 10^{-6}$ |
| Polypropylene, 200° C. | $-5.6 \times 10^{-9}$ | $-7.3 \times 10^{-6}$ |

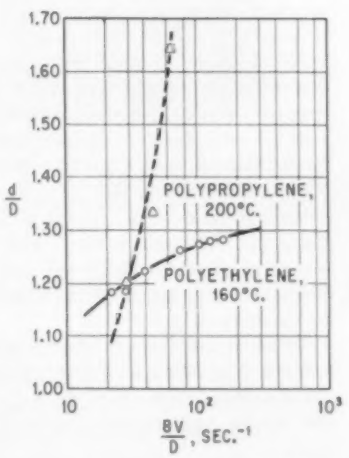
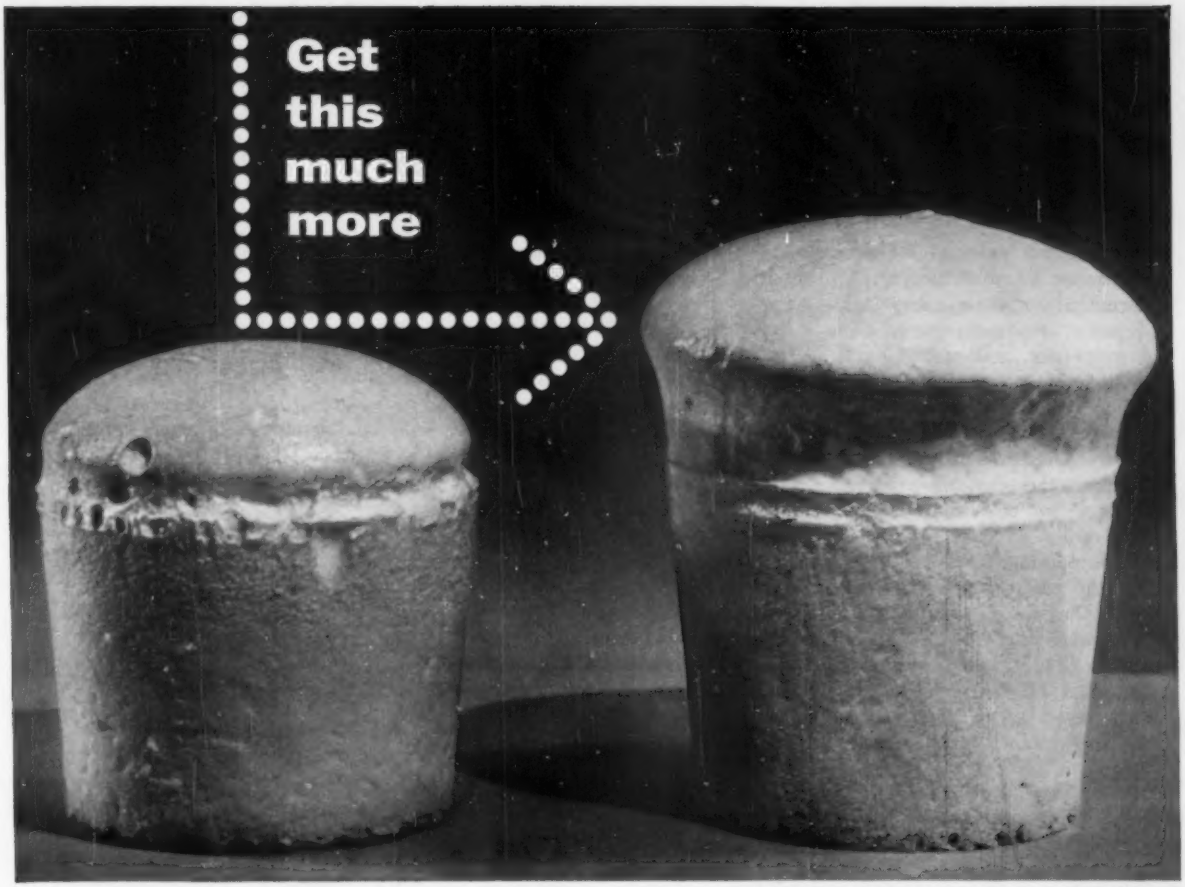



**FIG. 5:** Variation of the ratio of extrudate to tube diameter with 8 V/D. Molecular weights of fluids used: polypropylene, 300,000; polyethylene, 18,000.

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# Stabilization of mixed polyamides

By M. M. Epstein* and C. W. Hamilton*

Among the synthetic polymers of commercial value, polyamides are noted for their exceptional toughness, outstanding mechanical properties, and resistance to abrasion. However, these resins tend to degrade upon prolonged exposure to light or elevated temperatures. As a result of this development, the very properties for which they are most highly valued are severely affected by use in these environments.

For the past several years, the Signal Corps has sponsored a project at Battelle, the object of which was to develop improved nylon wire-jacketing compositions for outdoor use. Previous papers (1,2)[1] have described attempts to prepare novel polyamides that would be basically more stable to heat and light than conventional nylons. Several such compositions were developed. However, it was readily apparent that these polymers, despite their improved stability, were still unacceptable for direct and prolonged outdoor exposure. Consequently, a comprehensive program of evaluating various antioxidants, ultraviolet light absorbers, and other chemicals as stabilizers was undertaken.

Extensive research of this nature has been conducted in various industrial laboratories throughout the United States and Europe. Some of these findings have been summarized in scattered publications, and the patent literature abounds with descriptions of stabilizers that are proposed for improvement of the resistance of nylon to heat and/or light. Some of these additives are summarized in Table I, p. 144. Unfortunately, these disclosures are difficult to compare because of variations in evaluation technique and, in many cases, because quantitative data are not presented. Also, most of the experiments described in the patent literature were conducted either on conventional nylon homopolymers, such as polyhexamethylene adipamide, polyhexamethylene sebacamide, and polycaproamide, or simple copolymers of these nylons. The effect of these additives on the heat resistance of more complex polyamide systems is largely unknown or unpublished at the present time.

It is the purpose of this paper to present the results of experimental work conducted on five different mixed polyamide compositions. The subject of heat stability alone will be considered in detail, as this aspect is by itself a formidable problem.

The mechanism of the degradation of nylon upon exposure to heat or an outdoor environment is not completely understood. The polymer may deteriorate through any one, or all, of several routes. For example, polyamides are subject to oxidation and hydrolysis, and deterioration can also occur through chain scission and group attack, or even crosslinking. A wide variety of materials has been described as stabilizers; some act merely as antioxidants, whereas others are designed to react with the polymer itself and become an integral segment of the molecule, to block the reactivity of an end group.

### Preparation of polyamides

Many different mixed polyamides were included in this program. However, four particular polymers received chief attention, with some minor effort directed to a fifth. Of these polymers, three contained significant amounts of a heterocyclic ring structure, piperazine. The fourth contained minor amounts of aromatic materials, while the last was a completely aliphatic polymer. The polymers were selected on the basis of their initial properties, with qualities such as flexibility, abrasion resistance, and inherent heat stability being among the more important criteria. The work that led to their selection has been described elsewhere (1,2). The polymers investigated were as follows:

| *Polyamide* | *Weight ratio* |
|---|---|
| 66/610/6 | 65:10:25 |
| 66/6-Ø/6 | 65:10:25 |
| 66/610/pip-10 | 35:30:35 |
| 66/610/pip-6 | 35:30:35 |
| 66/610/pip-6 | 65:10:25 |

The symbol Ø designates isophthalic acid; the symbol pip designates piperazine.

All of the polymers evaluated in this program were synthesized by the melt condensation of the appropriate nylon salts. These preparations were conducted on a small scale using conventional glass apparatus, a convenient technique suitable for the polymerization of a large number of different polymers. Relatively small quantities, such as 50 to 75 grams of salt, were handled in this equipment to prepare adequate polymer for test purposes;

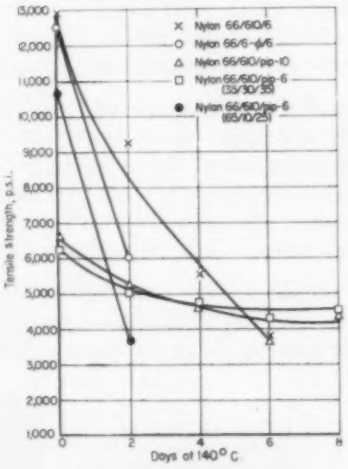


FIG. 1: Effect of heat aging on the tensile properties of unstabilized nylons.

*Battelle Memorial Institute.
[1]Numbers in parentheses denote references at end of article, p. 192.
Based on a paper presented at a meeting of the Division of Paint, Plastics, and Printing Ink Chemistry, American Chemical Society, Atlantic City, Sept. 1959.

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before use, the salts were adjusted to their respective isoelectric points to insure proper molecular weight control.

Briefly, the steps in the synthesis of these polymers were as follows: The salts, in the proper weight ratio, were charged to a glass reaction flask, along with a small quantity of adipic acid to serve as a molecular weight regulator. The salts were then heated to 225° C. under a nitrogen atmosphere, rapid agitation being applied once melting began. The water of condensation was refluxed back into the flask for approximately 2 hr. at a reaction temperature of 225° C., after which it was removed. The temperature was then raised to 280° C. and held constant for the remainder of the reaction. After all signs of polymerization had ceased at the higher temperature, the flask was slowly evacuated to a pressure of less than 2 mm. of mercury. Vacuum was maintained until the reaction ceased or the polymer became too viscous for the maintenance of proper agitation. This final stage usually required 1 to 4 hr., depending upon the nature of the reactants.

Most of the stabilizers were included as *in situ* additions to the salts prior to polymerization. In this way, the agitation maintained throughout the reaction was assumed to disperse the stabilizer throughout the polymer, particularly if the additive melted during

**Table I:** Description of polyamide stabilizer systems reported in the patent literature

| *Class of compound* | *Examples* | *Source* |
|---|---|---|
| Amino-hydrogen-containing aromatic amines with at least two aromatic carbocyclic nuclei-compounds having apparent oxidation potential between 0.70 v. and 1.30 v. | Phenyl-α-naphthylamine, β-naphthylamine, diphenylguanidine, phenothiazine, diphenylamine, sym-diphenylethylenediamine, 2-aminodiphenyl, diazoaminobenzene | U. S. Patent 2,278,350 |
| Bis-ortho-hydroxybenzamides | N,N′-hexamethylene-bis-*o*-hydroxybenzamide N,N′-ethylene-bis-*o*-hydroxybenzamine, etc. | U. S. Patent 2,302,819 |
| Metal salts of polycarboxylic acids, in which one acid group is not reacted with the metal | Sodium acetate, sodium stearate, mono-sodium succinate, mono-sodium phthalate, di-sodium citrate, zinc acetate, etc. | U. S. Patent 2,345,700 |
| Aryl-oxyacetic acids<br>Arylthioglycolic acids<br>Aryloxyalkylamines<br>Aminophenols | *o*-Hydroxyphenoxyacetic acid, p-N-phenyl-aminophenoxyacetic acid, 2-naphthylthioglycolic acid, 5-methoxy-1-naphthoxyacetic acid, *m*-hydroxybenzoic acid, *o*-aminophenol, p-amino-phenol, *o*-methoxyphenoxyethylamine | U. S. Patent 2,374,145 |
| Organic esters of phosphorous acid | Tricresylphosphite, triphenylphosphite, trimethylphosphite, triethylphosphite, dibutylphenylphosphite, trioctylphosphite, diamylphosphite, etc. Also thiophosphites | U. S. Patent 2,493,597 |
| Hypophosphorous acid compounds | Sodium hypophosphite, hypophosphorous acid, phenylphosphinic acid, diphenyl phenylphos-phinate, butyl phenylphosphinate, etc. | U. S. Patent 2,510,777 |
| Quinones | Benzoquinone, anthraquinone | U. S. Patent 2,597,163 |
| Nitroxides, hydrazyls, phenazyls | 1,1-Dimethyl-3-(N-phenyloximino) butylphenyl nitroxide, N-ethylphenazyl, 2,2-diphenyl-1-picrylhydrazyl, diphenylamino picryl nitroxide, N-diphenylamino-N-picrylhydroxylamine | U. S. Patent 2,619,479 |
| Alkaline-earth metal halides with a phosphorus compound | KI, KBr, $H_3PO_3$, and 2-mercaptobenzimidazole in various combinations | U. S. Patent 2,630,421 |
| Combination of a phosphorus compound and an inorganic halide | $H_3PO_3$, $NaH_2PO_4$, KI, KBr, methylphosphite, butylphosphite, butylphosphate, etc. | U. S. Patent 2,640,044 |
| Oxidizable metal | Magnesium, aluminum, strontium, and calcium | U. S. Patent 2,733,162 |
| Dicyandiamide | Dicyandiamide | U. S. Patent 2,758,985 |
| Phenol-formaldehyde resins | Phenol-formaldehyde, catechol-formaldehyde | Canadian Patent 514,148 |
| Copper compounds | Metallic copper, copper acetate, copper formate, copper carbonate, copper sulfite, etc. | French Patent 906,893 |
| Cycloalkyl-substituted aromatic polyhydroxyl compounds | Cyclohexylpyrocatechol, dicyclohexylpyrocatechol, cyclohexylresorcinol, cyclohexylhydroquinone, dicyclohexylpyrogallol | German Patent Application No. F16 245 (396,22/04) DAS No. 1 002 524 |

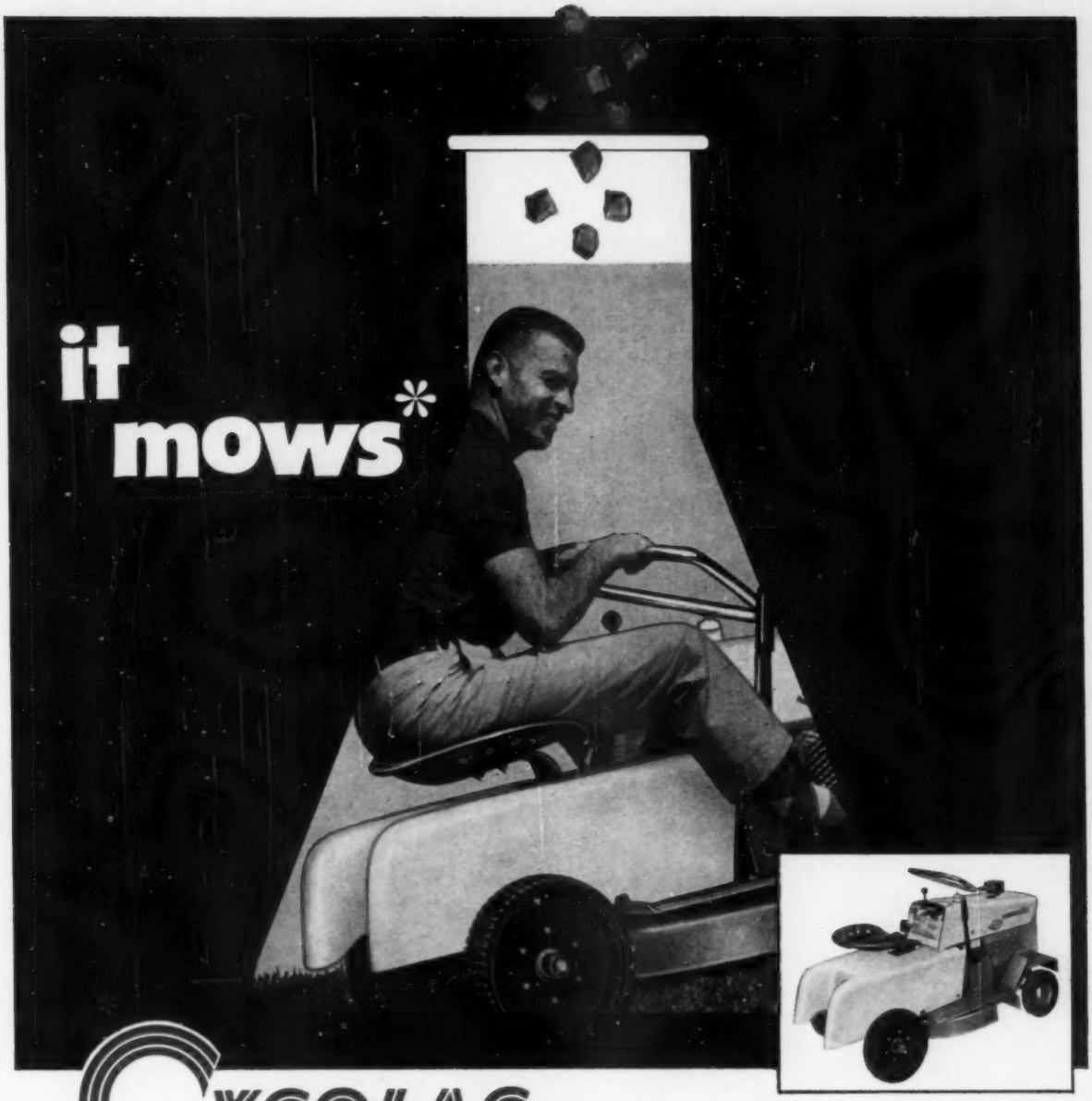


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**Table II:** Chemical compounds identified by tradenames or designations

| *Tradename* | *Chemical compound* |
|---|---|
| AgeRite White | Sym-di-β-naphthylphenylenediamine |
| AgeRite Hipar | Phenyl-β-naphthylamine, isopropoxydiphenylamine, diphenyl-phenylenediamine |
| AgeRite Powder | Phenyl-β-naphthylamine |
| AgeRite Gel | Ditolylamines |
| AgeRite Alba | p-Benzyloxyphenol |
| Dav-Ad 101 | 2,6-Di-*tert*-butyl-4-methylphenol |
| Ionol | 2,6-Di-*tert*-butyl-4-methylphenol |
| Suconox 12 | N-lauroyl p-aminophenol |
| Suconox 18 | N-stearoyl p-aminophenol |
| AgeRite Resin D | Polymerized trimethyldihydroquinoline |
| 115-51 | Catechol-formaldehyde resin |
| XR-254 | Catechol-formaldehyde resin |

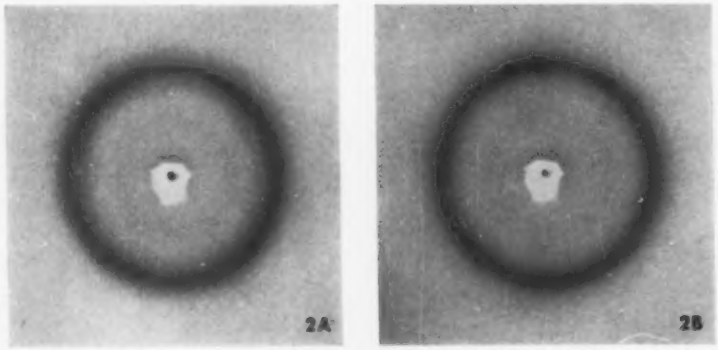



**FIG. 2:** Effect of heat aging on the X-ray diffraction pattern of nylon 66/610/6 monofilament. A) unaged; B) aged 8 days at 140° C.

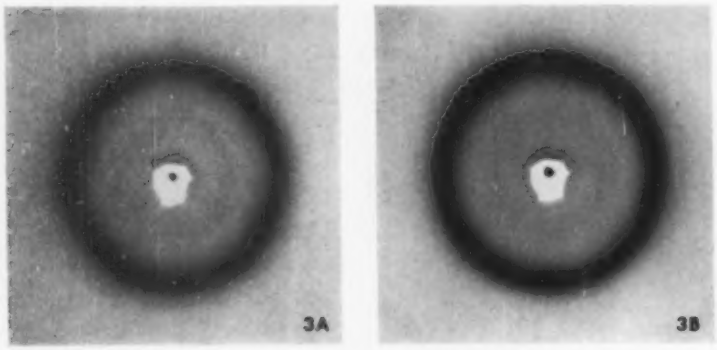
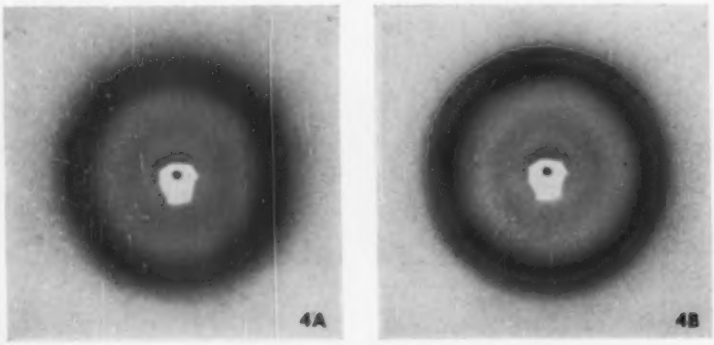



**FIG. 3:** Effect of heat aging on the X-ray diffraction pattern of nylon 66/6-ϕ/6 monofilament. A) unaged; B) aged 8 days at 140° C.

**FIG. 4:** Effect of heat aging on the X-ray diffraction pattern of nylon 66/610/pip-10 monofilament. A) unaged; B) aged 8 days at 140° C.




polymerization or was compatible with the polymer. In some cases, particularly with the amine-type stabilizers, it was assumed that the additives were reactive to the growing polymer, and became linked to the polyamide by means of primary valence bonds.

A few of the additives, such as hydroquinone, were known to boil below 280° C. under reduced pressure. It was necessary to add such additives after polymerization was complete. The actual operation consisted of reducing the temperature of the polymer slightly to 250° C., and while maintaining a slight positive pressure of nitrogen, adding the stabilizer. The flask was then sealed, and the polymer slowly stirred for at least 30 minutes. Because of the high viscosity of polyamides, even at 250° C., it is doubtful if in most cases a good dispersion was obtained. Because of this, melt-mixing was not desirable, and was avoided whenever possible.

The finished polymers were extruded into monofilaments, about 30 to 50 mils in diameter, using a modified Watson-Stillman injection molder. Testing was conducted on these filaments.

### Test procedures

A standard heat-aging test was employed throughout the course of this work (3). It consisted of placing nylon samples, in the form of monofilaments, in an air-circulating oven at a temperature of 140° C. for 8 days. The filaments were then conditioned for 10 days at 23° C. and 50% relative humidity prior to testing.

For our purposes, the changes in certain tensile properties during the aging period were of primary interest. Measurements were made of tensile strength, yield point, elongation, and brittleness temperature, both before and after aging. The degree to which these properties remained unaltered during aging was used as a measure of the relative effectiveness of the different additives and stabilizer systems. Discoloration during aging was not important to this study, and was ignored whenever it appeared. The tensile properties were determined on a Baldwin-Southwark machine according to a method quite simi-

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lar to that suggested in ASTM D638-52T. The brittleness temperature was measured in a Scott Model E Brittle Point Tester, following the standard procedure that is recommended by ASTM D746-44T.

The molecular weights reported in the tables were determined by intrinsic viscosity measurements of dilute solutions. Using *m*-cresol as a solvent, the following relationship was employed:

$$MW = [0.9\eta]^{-1.39} \times 13{,}000$$

where $\eta$ is the intrinsic viscosity.

### Nylon 66/610/6

Unstabilized, this polymer quickly deteriorates on oven aging, and usually is too brittle to test after only 2 days at 140° C. However, it readily responded to many different types of additives and, in many cases, showed a very small loss in tensile strength during the entire 8 days of aging. Retention of elongation was usually quite good, the chief signs of deterioration being an increase in yield point and discoloration. Aro-

**Table III:** Effect of chemical stabilizers on the tensile properties of nylon 66/610/6[a]

| Sample | Apparent molecular weight | Stabilizer concentration | Initial properties: Tensile strength | Initial properties: Yield strength | Initial properties: Elongation | Properties after aging 8 days at 140° C.: Tensile strength | Properties after aging 8 days at 140° C.: Yield strength | Properties after aging 8 days at 140° C.: Elongation | Brittleness temp. |
|---|---|---|---|---|---|---|---|---|---|
| | | wt. % | p.s.i. | p.s.i. | % | p.s.i. | p.s.i. | % | °C. |
| 2289 | 15,600 | None | 12,900 | 3,300 | 430 | Too brittle to test | | | |
| 2137 | 13,000 | 1.0 Suconox 12 | 11,300 | 3,200 | 460 | 5,100 | 4,400 | 30 | — |
| 2138 | 16,400 | 1.0 Suconox 18 | 13,900 | 4,100 | 450 | 8,600 | 5,300 | 370 | <−70 |
| 2113 | 13,600 | 1.0 p-aminophenol | 10,500 | 4,100 | 370 | 7,300 | 6,000 | 240 | — |
| 2183 | 17,600 | 1.0 Dav-Ad 100[b] | 9,300 | 3,200 | 330 | 5,900 | 0 | 30 | — |
| 2169 | 14,500 | 1.0 5-methyl-4-nitroso-2-isopropylphenol | 7,200 | 3,600 | 340 | 5,700 | 0 | 30 | — |
| 2170 | 16,700 | 1.0 AgeRite Alba | 7,000 | 3,300 | 390 | 5,200 | 0 | 40 | — |
| 2139 | 20,400 | 1.0 hydroquinone[b] | 10,800 | 3,000 | 400 | 9,000 | 5,100 | 350 | <−70 |
| 2420 | 12,400 | 1.0 hydroquinone diethyl ether | 10,550 | 3,100 | 440 | Too brittle to test | | | |
| 2460 | 14,600 | 1.0 hydroquinone dibenzyl ether | 10,300 | 3,400 | 400 | 5,500 | 0 | 10 | — |
| 2447 | 11,900 | 1.0 hydroquinone diacetate | 8,300 | 3,400 | 430 | 1,300 | 0 | 10 | — |
| 2135 | 15,400 | 1.0 quinone | 9,300 | 3,400 | 390 | 5,700 | 5,600 | 190 | — |
| 2446 | 11,700 | 1.0 2,5-di-*tert*-butyl-p-quinone | 8,450 | 3,200 | 370 | 3,850 | 0 | 10 | — |
| 2432 | 10,000 | 1.0 anthraquinone | 9,000 | 3,700 | 400 | Too brittle to test | | | |
| 2471 | 13,200 | 1.0 phenanthraquinone | 10,200 | 3,400 | 390 | Too brittle to test | | | |
| 2141 | 15,000 | 1.0 AgeRite White | 9,700 | 3,700 | 390 | 8,500 | 5,300 | 370 | <−70 |
| 2408 | 19,000 | 2.0 AgeRite White | 12,750 | 3,450 | 435 | 11,300 | 6,900 | 390 | −60 |
| 2140 | 15,300 | 1.0 AgeRite Hipar[b] | 13,500 | 3,700 | 420 | 10,000 | 5,300 | 450 | <−70 |
| 2184 | 16,900 | 2.0 AgeRite Hipar | 11,800 | 3,400 | 430 | 10,900 | 5,700 | 370 | <−70 |
| 2114 | 14,500 | 1.0 α-naphthylamine | 11,000 | 3,700 | 400 | Too brittle to test | | | |
| 2089 | 12,000 | 1.0 β-naphthylamine | 12,200 | 3,400 | 450 | 1,700 | 0 | 10 | — |
| 2090 | 17,800 | 1.0 phenyl-α-naphthylamine | 13,000 | 3,300 | 440 | 3,700 | 0 | 10 | — |
| 2134 | 18,100 | 1.0 AgeRite Powder | 12,900 | 3,200 | 415 | 10,400 | 5,100 | 370 | <−70 |
| 2112 | 14,600 | 1.0 *s*-diphenylethylenediamine | 11,700 | 4,000 | 400 | Too brittle to test | | | |
| 2201 | 9,700 | 1.0 p-phenylenediamine | 11,200 | 3,200 | 450 | 5,500 | 0 | 20 | — |
| 2091 | 16,300 | 1.0 phenothiazine | 12,600 | 3,600 | 440 | 6,300 | 5,400 | 240 | — |
| 2200 | 16,900 | 2.0 phenothiazine | 11,600 | 3,000 | 420 | 9,900 | 5,300 | 430 | <−70 |
| 1551 | 14,000 | 1.0 115-51 | 10,800 | 4,700 | 450 | 9,000 | 5,900 | 380 | −50 |
| 939 | 13,700 | 1.0 XR-254 | 10,100 | 4,100 | 400 | 8,200 | 5,500 | 350 | — |
| 656A | 14,000 | 1.0 KBr, 0.25$H_3PO_3$ 1.0 KI, 0.015Cu acetate | 9,400 | 3,300 | 400 | 9,000 | 5,500 | 356 | — |
| 2088 | 14,900 | 1.0 1,3-diphenylguanidine | 10,900 | 3,300 | 380 | Too brittle to test | | | |
| 2092 | 16,100 | 1.0 p-anisidine[b] | 12,500 | 3,100 | 390 | Too brittle to test | | | |
| 2171 | 17,000 | 1.0 AgeRite Resin D | 8,100 | 3,300 | 390 | 8,400 | 5,200 | 350 | −50 |
| 2181 | 16,000 | 1.0 AgeRite Gel | 11,300 | 3,500 | 350 | 7,600 | 5,100 | 270 | <−70 |

[a] Weight ratio, 65:10:25. [b] Stabilizer added by melt-mix for 0.5 hr. at 250° C.

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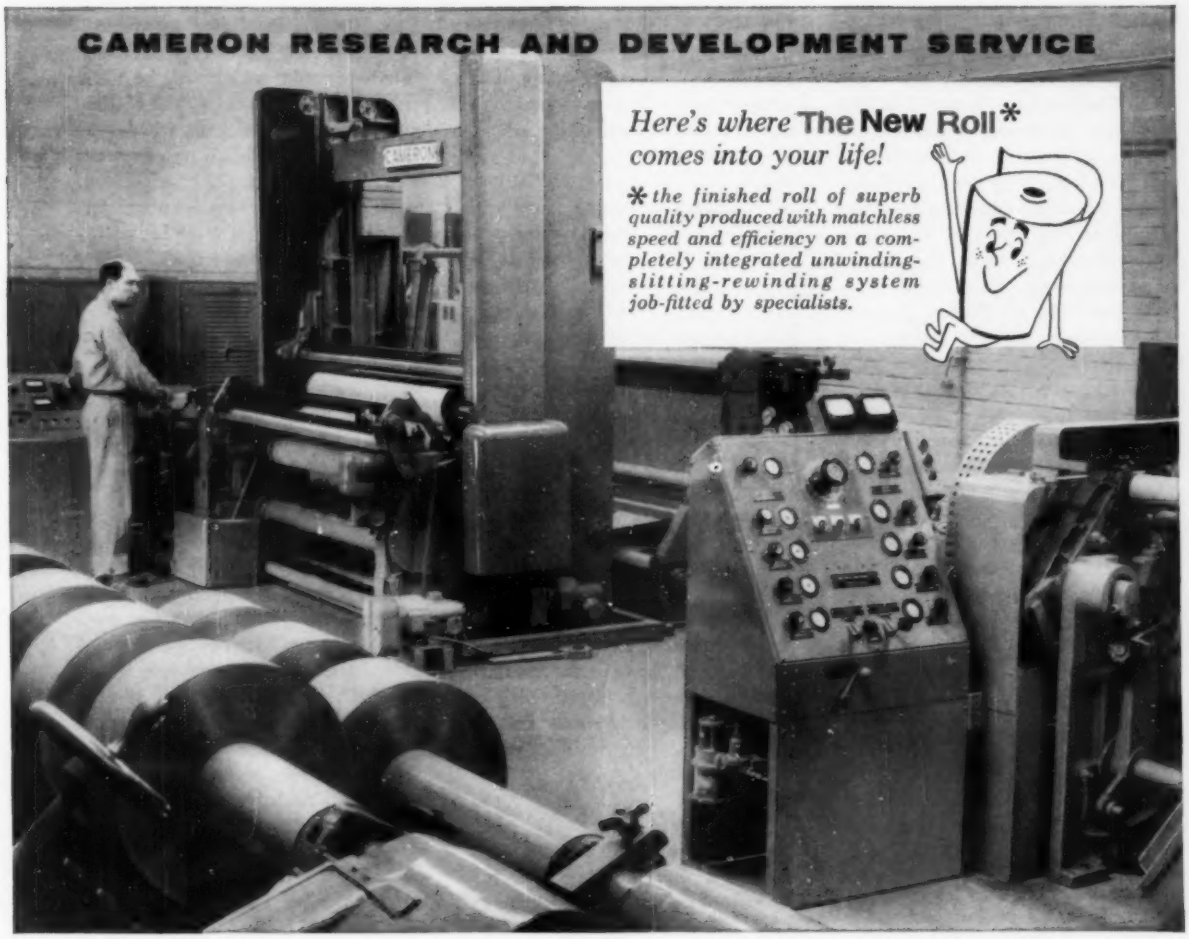
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matic amines, typified by commercial chemicals like AgeRite White, AgeRite Hipar, and AgeRite Powder (see Table II, p. 146, for their chemical composition), were particularly outstanding in stabilization, as shown in Table III, p. 148. Hydroquinone was also excellent, but none of the other quinone-type materials tested were adequate. Substituted phenols were also ineffective, but the aminophenols were in some cases quite good. Some stabilizer systems reported in the literature were found to work quite well in this polymer. This was particularly true of phenothiazine or the alkali metal salt-mineral acid combination of potassium bromide, potassium iodide, phosphorous acid, and copper acetate. On the other hand, some stabilizers reported as such were found to be of little help. Examples of such compounds were *p*-anisidine and 1,3-diphenylguanidine.

### Nylon 66/6-Φ/6

This polymer, except for the substitution of isophthalic acid for sebacic acid, is identical with the 66/610/6 polyamide. When it was first prepared, sebacic acid was classified as a material in critical supply because the imported castor bean was its primary source. Consequently, it was desirable to develop a polyamide that contained no sebacic acid. Since the mixed polyamide 66/610/6 contained only a small amount of sebacic acid (10% by weight of the 610 salt), it was assumed that the basic nature of the polymer would not be drastically altered by replacing the sebacic acid with a similar compound. The one proviso was that the substitute be available from synthetic processes at a reasonable cost. Such a material was isophthalic acid, and the replacement proved successful. The properties of the two polymers are quite similar, with the aromatic polymer seeming to be a little stiffer.

Because of the close similarity between the two polymers, it was further assumed that their reaction toward chemical stabilizers would be essentially alike. For this reason, a thorough screening of additives was not attempted with this polymer. In the samples tested, it behaved very much like the 66/610/6 nylon. Some of these results are shown in the data in Table IV, below.

### Nylon 66/610/pip-10

As shown by the curves in Fig. 1, p. 142, this polymer was inherently one of the most heat-stable nylons included in the program. Despite this apparent advantage, innumerable difficulties were encountered in attempts to raise its heat stability to an acceptable level. Except for one isolated example, which will be discussed later, nothing like the successes encountered with the 66/610/6 and 66/6-Φ/6 nylons was even approached. The additives used to such great advantage in the latter polymers were found to be completely inadequate with this piperazine-containing polymer. Chemicals such as AgeRite White, AgeRite Hipar, Suconox 18, catechol-formaldehyde resins, phenothiazine, phenyl-β-naphthylamine, and others provided only limited protection. The deterioration was still severe, with large decreases in tensile strength, elongation, and flexibility.

Early failures in stabilizing this polymer triggered an exhaustive examination of a large number of additives as heat stabilizers for this polymer. This program included the hydroxybenzenes, substituted phenols, aminophenols, quinone-type chemicals, and others. As was the case with the naphthylamines and other chemicals found useful in the 66/610/6 nylon, no positive results were obtained. The aging characteristics varied from no improvement at all, to a state best described as mediocre. Most of the data for these experiments are listed in Table V, right. Another approach to the chemi- **(To page 155)**

**Table IV:** Effect of chemical stabilizers on the tensile properties of nylon 66/6-Φ/6[a]

| Sample | Apparent molecular weight | Stabilizer concentration | Initial properties: Tensile strength | Initial properties: Yield strength | Initial properties: Elongation | Properties after aging 8 days at 140° C.: Tensile strength | Properties after aging 8 days at 140° C.: Yield strength | Properties after aging 8 days at 140° C.: Elongation | Brittleness temp. |
|---|---|---|---|---|---|---|---|---|---|
| | | wt. % | p.s.i. | p.s.i. | % | p.s.i. | p.s.i. | % | °C. |
| 1366 | 17,000 | None | 12,500 | 4,500 | 459 | Too brittle to test | | | |
| 2550 | 9,500 | 1.0 AgeRite White | 7,650 | 4,250 | 350 | 9,500 | 6,700 | 360 | —60 |
| 1697 | 9,500 | 2.0 115-51 | 10,200 | 5,500 | 380 | 7,600 | 7,400 | 350 | >0 |
| 1635 | 11,400 | 1.0 KBr, 0.25 $H_3PO_3$, 1.0 KI, 0.015 Cu acetate | 8,700 | 4,600 | 380 | 8,700 | 5,900 | 390 | <—70 |
| 1674 | 13,700 | 1.0 KBr, 0.25 $H_3PO_3$, 1.0 KI, 0.25 Cu stearate | 11,500 | 5,000 | 390 | 7,200 | 6,300 | 300 | — |
| 2564 | 15,000 | 1.0 AgeRite Hipar, 1.0 AgeRite White | 11,900 | 3,250 | 415 | 11,250 | 7,600 | 385 | —65 |

[a] Weight ratio, 65:10:25.

**Table V:** Effect of chemical stabilizers on tensile properties of nylon 66/610/pip-10[a]

| Sample | Apparent molecular weight | Stabilizer concentration | Initial properties | | | Properties after aging 8 days at 140° C. | | |
|---|---|---|---|---|---|---|---|---|
| | | | Tensile strength | Yield strength | Elongation | Tensile strength | Yield strength | Elongation |
| | | wt. % | p.s.i. | p.s.i | % | p.s.i. | p.s.i. | % |
| 1015A | 16,300 | None | 8,500 | 2,800 | 430 | 4,200 | 4,200 | 100 |
| 1288 | 11,500 | 1.0 Suconox 18 | 6,700 | 3,100 | 480 | 4,000 | 4,000 | 50 |
| 1217 | 10,600 | 1.0 p-amino phenol | 7,400 | 2,800 | 400 | 4,600 | 4,400 | 200 |
| 1222 | 9,600 | 1.0 Ionol | 6,600 | 3,000 | 430 | 4,000 | 0 | 40 |
| 1228 | 18,100 | 1.0 5-methyl-4-nitroso-2-isopropyl phenol | 6,900 | 3,200 | 410 | 4,800 | 4,500 | 160 |
| 1229 | 11,300 | 1.0 4-*tert*-butyl catechol | 7,300 | 3,300 | 390 | 4,000 | 0 | 40 |
| 999 | 15,400 | 1.0 resorcinol | 9,000 | 3,100 | 430 | 4,300 | 4,300 | 50 |
| 995 | 15,900 | 1.0 pyrogallol | 7,400 | 3,100 | 430 | 3,500 | 0 | 20 |
| 965 | 8,400 | 1.0 phloroglucinol[b] | 6,900 | 4,100 | 410 | 5,200 | 5,200 | 60 |
| 989 | 12,800 | 1.0 bisphenol A | 9,300 | 3,000 | 470 | 4,200 | 4,200 | 90 |
| 1005 | 14,300 | 1.0 catechol | 10,100 | 2,800 | 500 | 4,400 | 4,400 | 200 |
| 1305 | 10,900 | 1.0 quinone | 6,500 | 3,300 | 400 | 4,100 | 4,100 | 100 |
| 1205 | 18,000 | 1.0 AgeRite White | 9,300 | 3,300 | 450 | 5,400 | 4,200 | 50 |
| 2610 | 15,200 | 2.0 AgeRite White | 9,000 | 2,500 | 380 | 6,150 | 4,700 | 250 |
| 1219 | 12,800 | 1.0 AgeRite Hipar | 8,400 | 2,900 | 450 | 4,200 | 4,200 | 60 |
| 1218 | 10,600 | 1.0 phenyl-β-napthyl-amine | — | — | — | 4,300 | 4,300 | 50 |
| 1304 | 12,600 | 1.0 N,N′-diphenyl ethylenediamine | 6,900 | 3,200 | 440 | 4,100 | 4,100 | 60 |
| 1211 | 15,600 | 1.0 o-phenylenediamine | 8,200 | 3,100 | 430 | 4,300 | 4,300 | 60 |
| 1204 | 13,400 | 1.0 p,p′-methylene dianiline | 8,900 | 3,800 | 400 | 4,300 | 4,300 | 70 |
| 1292 | 8,500 | 1.0 p-nitroso-dimethyl-aniline | 6,400 | 3,400 | 440 | 4,200 | 4,200 | 70 |
| 1082 | 14,700 | 1.0 phenothiazine | 7,700 | 2,900 | 400 | 4,400 | 4,100 | 200 |
| 1293 | 12,400 | 2.0 phenothiazine | 9,300 | 3,200 | 450 | 4,500 | 4,200 | 250 |
| 987 | 19,000 | 1.0 XR-254 | 8,500 | 3,000 | 400 | 6,000 | 4,500 | 180 |
| 1212A | 10,500 | 2.0 XR-254 | 6,600 | 3,800 | 360 | 4,400 | 4,500 | 70 |
| 1239 | 13,800 | 1.0 115-51 | 6,500 | 3,300 | 336 | 4,900 | 4,600 | 200 |
| 1256 | 11,900 | 2.0 115-51 | 5,500 | 3,200 | 360 | 5,100 | 4,700 | 220 |
| 1062 | 17,000 | 1.0 pyrogallol-formaldehyde resin | 8,400 | 3,200 | 430 | 4,900 | 4,300 | 170 |
| 1216 | 11,300 | 1.0 o-phenylenediamine-formaldehyde reaction product | 7,400 | 3,300 | 430 | 4,300 | 4,300 | 60 |
| 938 | 7,800 | 1.0 KBr, 0.25$H_3PO_4$ 1.0 KI, 0.015Cu acetate | 4,100 | 3,100 | 283 | 3,500 | 0 | 20 |
| 1048 | 12,600 | 1.0 KBr, 0.03Cu acetate 0.25$NaH_2PO_4$ | 6,200 | 3,200 | 370 | 5,100 | 4,400 | 200 |
| 1246 | 11,300 | 1.0 tricresyl phosphate | 6,400 | 3,000 | 390 | 4,100 | 0 | 20 |
| 1362 | 9,800 | 1.0 AgeRite White 1.0 phenothiazine[c] | 7,900 | 3,500 | 430 | 4,900 | 4,400 | 230 |
| 1332 | 11,700 | 1.0 AgeRite White[b] 1.0 115-51 | 8,500 | 3,400 | 450 | 5,100 | 4,600 | 230 |
| 2609 | 11,800 | 1.0 AgeRite White 1.0 AgeRite Hipar | 10,250 | 2,600 | 430 | 7,200 | 4,900 | 460 |
| 1252 | 15,600 | 1.0 115-51 1.0 phenothiazine[c] | 7,600 | 2,800 | 460 | 5,700 | 4,200 | 260 |
| 1349 | 13,200 | 1.0 115-51 1.5 phenothiazine[c] | 9,500 | 4,100 | 450 | 5,600 | 4,700 | 230 |
| 1348 | 14,100 | 1.0 115-51 2.0 phenothiazine[c] | 8,800 | 3,700 | 400 | 6,600 | 4,600 | 250 |
| 1508 | 25,000+ | 1.0 115-51 3.0 phenothiazine[c] | 7,100 | 2,700 | 450 | 5,200 | 4,800 | 200 |
| 1505 | 24,200 | 2.0 115-51 2.0 phenothiazine[c] | 6,500 | 2,900 | 420 | 4,700 | 0 | 40 |

[a] Weight ratio, 35:30:35.
[b] Stabilizer added by melt-mix at 250° C. for 1 hr.
[c] Stabilizer added by melt-mix for 0.5 hr. at 250° C.

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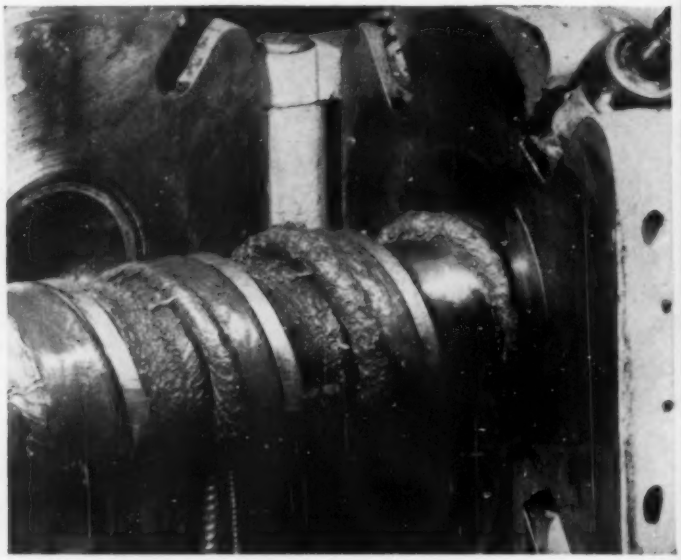
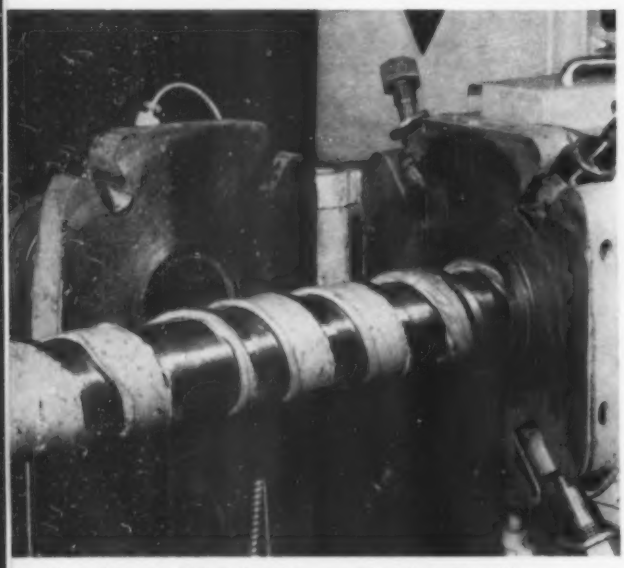
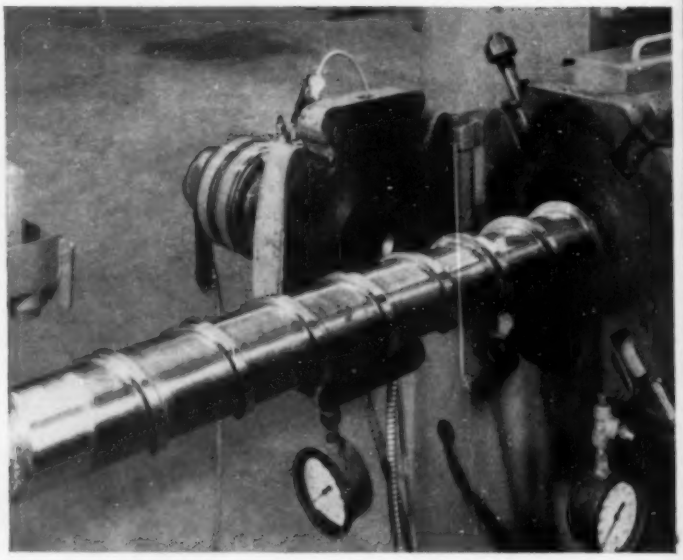


**2.** Operate machine to purge old material.



**3.** Note how A-C Cleaning Compound strips off easily.



**4.** In hours—not days—a clean machine ready for the next run!

If you've been losing days and dollars in making change-overs, here's good news! Allied's Semet-Solvay Petrochemical Division has now developed a cleaning compound that will completely remove any thermoplastic material—and do it in a fraction of the time normally required. The simple procedure is pictured above.

One extruder tells us that he saves $5,000 by using A-C® Cleaning Compound—cleans a machine in 1½ hours without tearing it down.

You'll find A-C Cleaning Compound speeds changing material or colors, and eliminates cylinder contamination. It purges without scratching and strips cleanly and easily from extrusion screws without mess.

For a free bulletin telling how this new cleaning compound can save *you* time and money, just write us at the address below.

Allied Chemical

**SEMET-SOLVAY PETROCHEMICAL DIVISION**

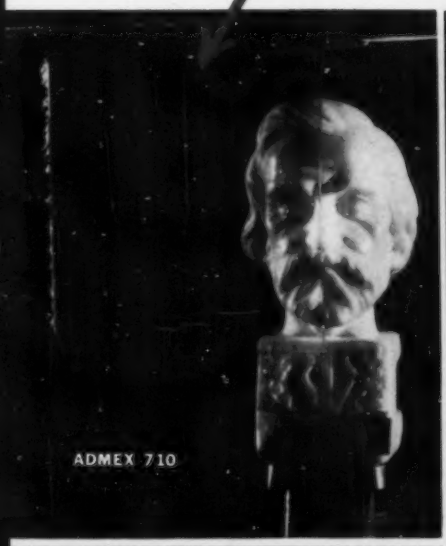
Dept. 576-Y, 40 Rector Street, New York 6, N. Y.

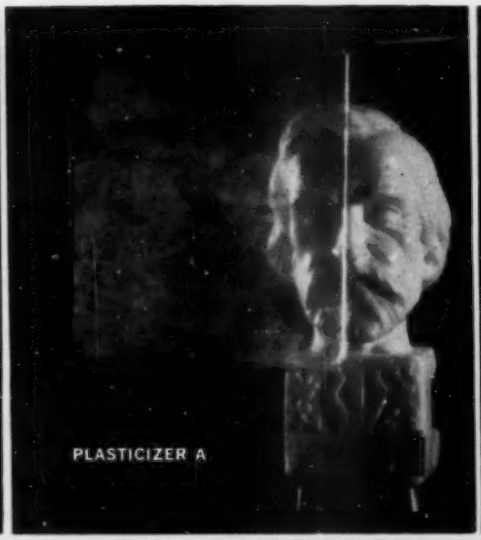
*National Distribution • Warehousing in Principal Cities*

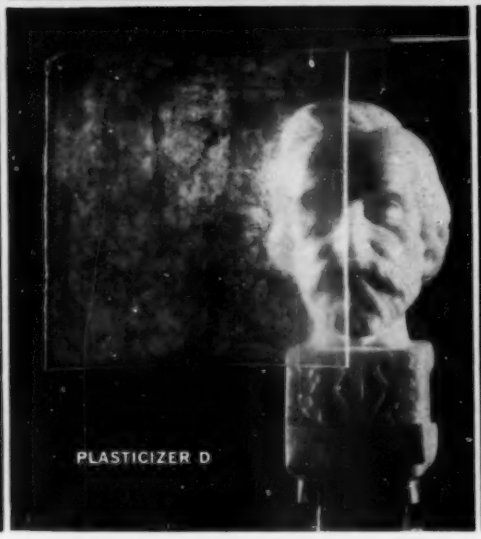
# *Compare*

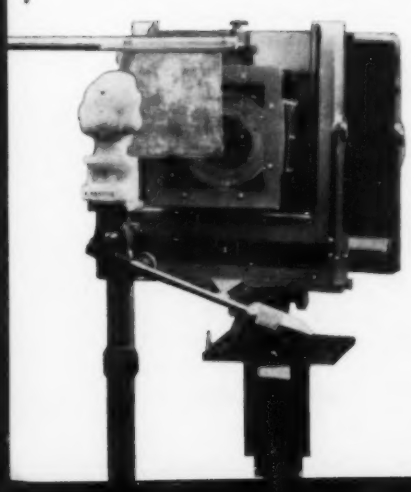
## ADMEX 710 CLEARLY SUPERIOR IN AGE TEST

Compare the compatability of ADMEX 710 epoxy plasticizer with that of five competing products:







Here are unretouched photographs of vinyl test sheets* exactly as they appear after aging. Compare. Note the heavy, waxy plasticizer exudation on the vinyl sheets formulated with competitive epoxies. Then note the perfect clarity of the ADMEX 710 sheet. As you see, ADMEX 710 shows no sign of spewing after 12 months' aging. This proves marked superiority not found in most competitive products.

ADMEX 710 serves double-duty as plasticizer and stabilizer. It permits important economy in compounding all vinyls . . . provides outstanding heat and light stability, as well as resistance to migration and extraction in calendered, extruded, molded, and cast vinyl compounds.

For further information on this exudation test, and on ADMEX PLASTICIZERS, write, wire, or call your ADM representative today.

**Archer-Daniels-Midland**

**Chemical Group**

**RESINS · PLASTICS**
**INDUSTRIAL CHEMICALS**

700 Investors Building, Minneapolis 2, Minn

*Compounded of 50 parts epoxy plasticizer to 100 parts polyvinyl chloride resin. (Not a recommendation for the use of epoxidized soybean oil, but a comparative test compound.) Stored in individual paper envelopes in the dark at room temperatures, some sheets showed pronounced exudation in as little as four months. ADMEX 710 sheets were clear after 12 months' aging. Similar comparative data were observed in north light window exposures between three and six months.

**Table VI:** Effect of chemical stabilizers on the tensile properties of nylon 66/610/pip-6

| Sample (ratio) | Apparent molecular weight | Stabilizer concentration | Initial properties: Tensile strength | Initial properties: Yield strength | Initial properties: Elongation | Properties after aging 8 days at 140° C.: Tensile strength | Properties after aging 8 days at 140° C.: Yield strength | Properties after aging 8 days at 140° C.: Elongation |
|---|---|---|---|---|---|---|---|---|
| *35:30:35* | | *wt. %* | *p.s.i.* | *p.s.i.* | *%* | *p.s.i.* | *p.s.i.* | *%* |
| 858 | 12,600 | None | 6,200 | 2,800 | 400 | 4,500 | 4,400 | 80 |
| 2606 | 13,300 | 1.0 Suconox 18 | 8,000 | 2,400 | 390 | 3,900 | 0 | 25 |
| 2565 | 11,700 | 1.0 AgeRite White | 5,900 | 2,950 | 275 | 5,725 | 5,275 | 225 |
| 2572 | 14,000 | 2.0 AgeRite White | 6,000 | 2,550 | 400 | 5,000 | 4,300 | 140 |
| 2136 | 12,700 | 1.0 AgeRite Hipar | 5,600 | — | 470 | 4,500 | 0 | 40 |
| 2578 | 14,800 | 2.0 AgeRite Hipar | 7,500 | 2,500 | 355 | 5,100 | 4,900 | 230 |
| 2074 | 11,300 | 1.0 phenothiazine | 5,500 | 3,400 | 200 | 3,500 | 0 | 30 |
| 2043 | 9,000 | 2.0 phenothiazine | 6,400 | 3,100 | 310 | 4,300 | 4,300 | 50 |
| 2029 | 9,000 | 1.0 115-51 | 5,400 | 4,300 | 190 | 4,500 | 4,300 | 80 |
| 2041 | 14,900 | 2.0 115-51 | 8,000 | 3,700 | 300 | 6,000 | 5,200 | 120 |
| 2045 | 15,500 | 3.0 115-51 | 5,500 | 2,700 | 370 | 6,500 | 4,400 | 200 |
| 2607 | 11,000 | 1.0 AgeRite White<br>1.0 Suconox 18 | 7,600 | 2,400 | 350 | 6,800 | 5,250 | 175 |
| 2558 | 12,200 | 1.0 AgeRite White<br>1.0 AgeRite Hipar | 6,950 | 2,500 | 335 | 5,450 | 4,350 | 230 |
| 2573 | 12,500 | 1.0 AgeRite White<br>1.0 phenothiazine | 6,000 | 2,400 | 350 | 5,450 | 4,800 | 240 |
| 2575 | 14,600 | 1.0 AgeRite White<br>2.0 phenothiazine | 7,200 | 2,400 | 350 | 5,100 | 5,100 | 150 |
| 2608 | 11,900 | 1.0 AgeRite Hipar<br>1.0 Suconox 18 | 8,300 | 2,300 | 410 | 5,500 | 3,900 | 200 |
| 2574 | 13,300 | 1.0 AgeRite Hipar<br>1.0 phenothiazine | 6,900 | 2,500 | 410 | 4,650 | 4,200 | 145 |
| 2116 | 12,700 | 1.0 AgeRite Hipar<br>1.0 115-51 | 6,400 | 3,450 | 310 | 5,800 | 4,300 | 220 |
| 2605 | 10,400 | 1.0 phenothiazine<br>1.0 Suconox 18 | 7,850 | 2,500 | 435 | 5,550 | 4,200 | 220 |
| 1825 | 13,400 | 1.0 phenothiazine[a]<br>1.0 115-51 | 6,400 | 2,200 | 340 | 6,400 | 3,900 | 200 |
| 2042 | 13,800 | 1.0 phenothiazine<br>2.0 115-51 | 6,500 | 3,500 | 340 | 6,500 | 5,100 | 150 |
| 2077 | 13,500 | 3.0 phenothiazine<br>2.0 115-51 | 6,300 | 3,300 | 400 | 5,200 | 4,500 | 150 |
| 2417 | 13,700 | None | 10,600 | 3,600 | 425 | Too brittle to test | | |
| *65:10:25* | | | | | | | | |
| 2561 | 4,800 | 1.0 Suconox 18 | 8,500 | 3,500 | 370 | 4,250 | 0 | 10 |
| 2551 | 5,000 | 1.0 AgeRite White | 6,700[b] | 3,900 | 270 | 9,000 | 6,300 | 290 |
| 2559 | 10,500 | 1.0 AgeRite Hipar | 9,200 | 3,500 | 360 | 8,100 | 6,700 | 330 |
| 2560 | 12,800 | 1.0 phenothiazine | 8,700 | 3,900 | 300 | Too brittle to test | | |
| 2553 | 16,600 | 1.0 AgeRite Hipar<br>1.0 AgeRite White | 10,300 | 3,600 | 360 | 10,200 | 7,200 | 350 |

[a] Stabilizer added by melt-mix for 0.5 hr. at 250° C.
[b] Questionable data.

**Table VII:** Correlation of change in tensile properties with crystallinity during aging

| Sample | Nylon | Stabilizer concentration | Initial properties: Tensile strength | Initial properties: Yield point | Initial properties: Elongation | Properties after aging 8 days at 140° C.: Tensile strength | Properties after aging 8 days at 140° C.: Yield point | Properties after aging 8 days at 140° C.: Elongation | Degree of crystallinity of aged sample from X-ray photogram |
|---|---|---|---|---|---|---|---|---|---|
| | | *wt. %* | *p.s.i.* | *p.s.i.* | *%* | *p.s.i.* | *p.s.i.* | *%* | |
| 2503 | 66/610/6 | 1.0 AgeRite White | 9,500 | 3,100 | 400 | 10,800 | 5,400 | 410 | Amorphous |
| 2601 | 66/610/6 | 1.0 AgeRite White<br>1.0 AgeRite Hipar | 11,100 | 3,200 | 365 | 10,900 | 6,700 | 400 | Slightly crystalline |
| 2610 | 66/610/pip-10 | 2.0 AgeRite White | 9,000 | 2,500 | 380 | 6,150 | 4,700 | 250 | Very crystalline |

cal stabilization of this polymer was to use combinations of some of the stabilizer systems that seemed to work on other polymers. It was hoped that a synergistic effect might be obtained, or that the stabilizing effect of the various additives might be partially cumulative. In most instances no improvement was obtained. This is aptly demonstrated by the data presented in Table V. In one isolated instance, that in which AgeRite White and AgeRite Hipar were combined, a significant improvement in heat stability was observed. Although aging of this sample (No. 2609) resulted in a net loss of approximately 30% in tensile strength, for the first time there was no loss in elongation. Additional samples of this polyamide were subsequently synthesized, but did not completely confirm the data of Sample No. 2609. This sample represents only one case of effective heat stabilization in this piperazine polyamide.

### Nylon 66/610/pip-6

Two polyamides of this composition were included in this program, differing only in the ratios of the respective component. One composition consisted of nylon salts 66, 610, and pip-6 in a 35:30:35 weight ratio. This, of course, is the same ratio as used in the pip-10 polyamide, with the only difference being replacement of sebacic acid by adipic acid in the piperazine salt. Of all the terpolymers examined in which piperazonium adipate was a starting material, the 35:30:35 ratio of components was found to yield by far the most heat-stable polymer. Like the pip-10 polyamide, this nylon was inherently far more stable to thermal degradation than the 66/610/6 nylon. Also, like the pip-10 polyamide, the same difficulties in finding effective heat stabilizers for it were encountered. The screening of additives was not nearly as exhaustive, being confined to those which had proven effective in the 66/610/6 nylon. However, only partial stabilization was obtained, with degradation manifesting itself by large losses in elongation and flexibility during aging. These data are shown in Table VI, p. 154. Many additives were also evaluated in combination in the 35:30:35 composition, as illustrated in Table VI, but results of this research were not satisfactory.

The second composition studied contained less piperazine, and consisted of nylons 66, 610, and pip-6 in a 65:10:25 ratio. It was felt that this composition, being more like the 66/610/6 nylon, might respond in a similar manner to particular additives, despite the fact that the polymer itself was not as stable as the 35:30:35 composition. As shown in Table VI, this did occur in some cases, particularly with AgeRite Hipar and the combination of AgeRite Hipar and AgeRite White. However, in both cases, the sharp increase in the value of the yield point was considered too great.

### Effectiveness of stabilizers

From the data presented in Tables III to VI, it is apparent that the relative effectiveness of heat stabilizers varies from one polyamide composition to another. For example, ordinary antioxidants, such as the AgeRite compounds, considerably improve the heat stability of nylon 66/610/6 and nylon 66/6-$\phi$/6. However, in the polyamides containing piperazine, the degree of stabilization attained with the same additives was not as great. At best, these piperazine polyamides still exhibited a loss in elongation and **(To page 190)**

**Table VIII:** Effect of molecular weight on the heat resistance of mixed polyamides

| Sample | Nylon | Apparent molecular weight | Stabilizer concentration | Initial properties: Tensile strength | Initial properties: Yield strength | Initial properties: Elongation | Properties after aging 8 days at 140°C.: Tensile strength | Properties after aging 8 days at 140°C.: Yield strength | Properties after aging 8 days at 140°C.: Elongation | Brittleness temp. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | wt. % | p.s.i. | p.s.i | % | p.s.i. | p.s.i. | % | °C. |
| 2408 | 66/610/6[a] | 19,000 | 2.0 AgeRite White | 12,750 | 3,450 | 435 | 11,300 | 6,900 | 390 | —60 |
| 2237 | 66/610/6[a] | 4,900 | 2.0 AgeRite White | 6,900 | 4,000 | 360 | 6,900 | 6,900 | 60 | — |
| 2600 | 66/6-$\phi$/6[a] | 14,200 | 1.0 AgeRite White 1.0 AgeRite Hipar | 12,900 | 3,100 | 385 | 10,950 | 7,050 | 350 | <—65 |
| 2549 | 66/6-$\phi$/6[a] | 8,800 | 1.0 AgeRite White 1.0 AgeRite Hipar | 7,800 | 4,350 | 350 | 7,350 | 6,600 | 140 | 0 |
| 1082 | 66/610/ pip-10[b] | 14,700 | 1.0 phenothiazine | 7,700 | 2,900 | 400 | 4,400 | 4,100 | 200 | — |
| 2625 | 66/610/ pip-10[b] | 6,000 | 1.0 phenothiazine | 5,800 | 3,700 | 430 | 5,000 | 5,000 | 55 | — |

[a] Weight ratio, 65:10:25.
[b] Weight ratio, 35:30:35.

# NEW DEVELOPMENTS

**Many minds at work on new ways to use plastics, new designs, and new product concepts offer ideas you can use.**

## New roof concept based on foamed styrene

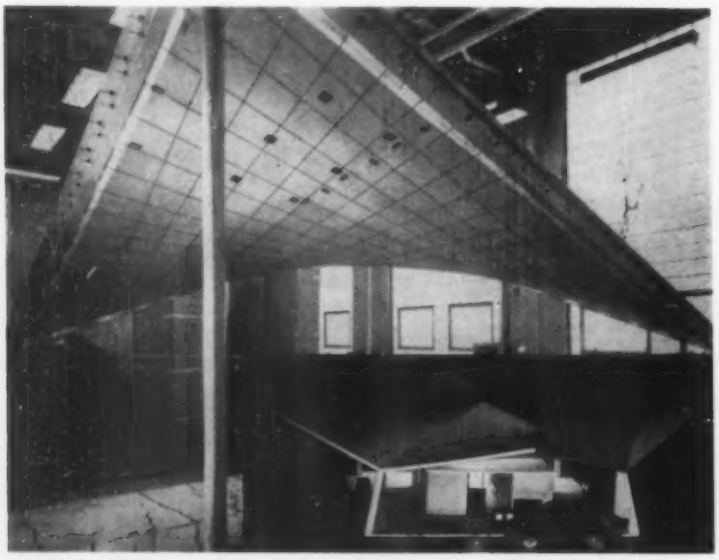
Of late, architects and builders have shown a growing interest in thin-shell roof construction to cover large, arena-type buildings. Such structures span the entire building without supporting girders, trusses, columns, and the like, and are generally made of concrete. However, cost has been a serious deterrent. The curved shapes of these roofs require elaborate support during the concrete curing period, and often make the price prohibitive.

Now, Dow Chemical Co. engineers have suggested a new approach to this problem, based on Styrofoam board. The approach introduces foamed plastic planks in a triple capacity: 1) as a form for the permanent roof; 2) as thermal insulation; and 3) as a vapor barrier. In use, the boards are bent to the roof contour and become an integral part of the roof structure. They also provide a base for interior decoration.

In a large-scale experimental model erected at Purdue University, construction consisted of lattices of wires over and under the Styrofoam, which created the hyperbolic paraboloid shape and caused the plastic to act as a shell membrane.

Plans are underway to build a partially enclosed structure on the Purdue golf course, according to Dow. This would be a 30- by 30-ft. hyperbolic paraboloid roof with a weatherproof concrete surface. Other building programs are also being actively pursued by Dow.

According to F. J. McGarry, of MIT, "the use of Styrofoam as a construction aid in the fabrication of thin-shell concrete structures could well prove to be one of the most significant advances in building technology since the advent of curtain wall construction. The construction economies and architectural freedom which can be simultaneously achieved with this new technique will certainly expand use of these new buildings far beyond their present rather narrow limits. It represents one of the most intelligent and rational combinations of the dynamic field of plastics with that of civil engineering which has yet occurred," he said.



**CLOSE-UP ELEVATION** from high corner of 20- by 20-ft. shell constructed of Styrofoam and wire lattice at Purdue University. Inset shows model of service station with a multiple hyperbolic paraboloid roof.

## Outdoor sculpture

Unusual designs in reinforced plastics "sculpture" are now adding beauty and interest to landscapes as well as interior decor. Produced by California Art Products Co., North Hollywood, Calif., the line includes several waterfalls, giant turtles for pool display, variety of rocks, and bas reliefs of various subjects for use as plaques. Aside from private use, the pieces have also found application in a variety of displays for store decorations.

**WOODLAND WATERFALL,** molded of reinforced plastics in one piece, weighs 50 lb.; is 42 by 44 by 61 in. high.

Prices range form $4.95 for the smallest rock to $250 for the largest simulated waterfall.

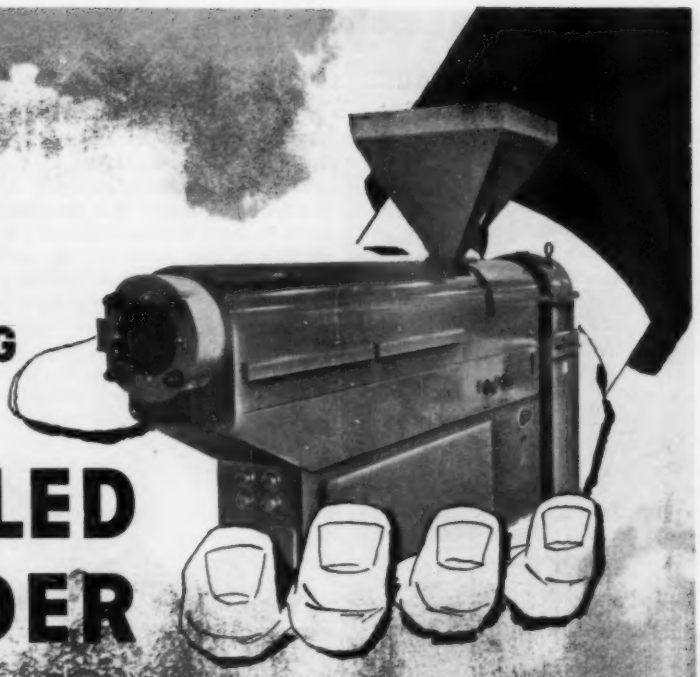
The displays are produced in flexible molds of reinforced polyester, using the hand lay-up and spray-up method. Resin is supplied by Reichhold Chemicals Inc., fibrous glass reinforcement by Owens-Corning Fiberglas Corp. Colors are molded in as necessary.

These pieces are designed to duplicate the appearance and texture of stone. Their big advantage is that they weigh only a small fraction of such stone.

## New siding component

Durability, lower costs, lighter weight, fire resistance, colorful finish, and more rapid construction are among the advantages claimed for a new type of reinforced epoxy roofing and siding material developed by Shieldcoat International Inc., Chicago, Ill. The company is now getting into initial production of the prefabricated reinforced plastics roofing and siding, which carries the tradename of Shieldite.

According to designer Richard A. Gordon, company **(To page 158)**



# INTRODUCING THE EGAN AIR COOLED EXTRUDER

Here is the air cooled extruder that offers more effective cooling than any other comparable model on the market today!

Each cylinder zone on the new Egan Air Cooled Extruder is fitted with a high capacity blower. Air from each blower is channeled through the ductwork and a specially designed chamber for a completely dependable, high-velocity flow along the periphery of the zone. You get maximum uniform cooling!

In addition, the Egan Air Cooled Extruder retains all the time tested and proven features found in Egan's other extruder lines—heavy duty thrust bearings, herringbone gear speed reducers, and a host of other operating and maintenance features.

Whatever your requirement in extruders—air cooled, direct electric heat, or "Willert Temperature Control System"—Egan can meet your every need.

Egan Extruders are available in sizes from 2" through 10" with L/D ratios from 20:1 through 32:1.

FREE—Write for your Egan Extrusion Speed Calculator for film, coating and laminating.

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MEXICO—M. H. GOTTFRIED, Mexico, D.F.

*(From page 156)*

president and originator of the product, it is suitable for modern-style flat and low-pitched residential or other roofing. The 45-lb. per square (100 sq. ft.) weight of the roofing compares with as much as 175 to 300 lb. per square for some older types in general use. Actual weight of the resin involved is about 11½ lb. per 100 sq. feet.

Finished roofing and siding panels, it is claimed, are acid, alkali, corrosion and erosion resistant and cannot oxidize, rot, or deteriorate. The good thermal insulating properties of the material make it suitable for use in either hot or cold climates, while its flexibility permits it to flex with the structure. If ultimately damaged, it is easily and inconspicuously repaired by patching.

Factory prefabrication of the panels, made in 2 by 8 ft. and other sizes, begins with a conventional roof decking or side paneling base such as plywood or rigid insulation board. Over the base is stretched a layer of 1 oz. per sq. yd. fibrous glass cloth to add increased surface strength. In the next step of the process, a thin coat of specially formulated epoxy resin and hardener combination is applied to the cloth. Before the liquid resin hardens, it is surfaced with mineral granules of selected color. Loose granules are then brushed off after the resin has been allowed to cure.

In installing the roofing panels, the process of flashing around chimneys, etc., and closing panel joints is handled by means of strips of the glass cloth, surfaced with activated resin and following up with matching mineral granules, producing invisible joints. Before applying the cloth and resin, joints are covered with pressure-sensitive tape.

Epoxy resin used in the Shieldite panels, specially formulated for this application, is of the fire-retardant type.

**MODEL** shows flashing around chimney. Flashing is applied by means of glass cloth and resin and mineral surfacing. Excess mineral granules are brushed off.

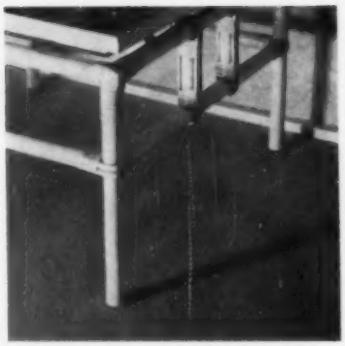
## Vinyl carpeting

Simulating woven construction, both in appearance and resilience, new vinyl carpeting material, produced by U. S. Rubber Co., Mishawaka, Ind., offers a durable floor covering for both indoor and outdoor applications. It can be washed and vacuum cleaned, and is said to resist the effects of weathering and mildew, as well as water-spotting.

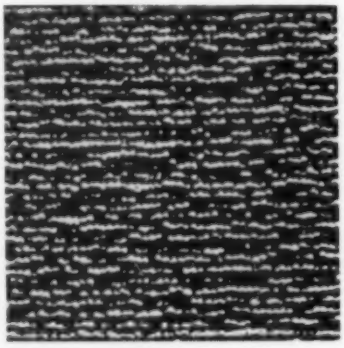
Suggested applications are in hotels, motels, restaurants, beach and pool clubs, banks, offices, hospitals, schools, showrooms, and homes. The carpeting can be laid down directly on most types of flooring, but if surface protection is desired on asphalt tile, linoleum, or lacquered surfaces, a felt padding is recommended for use between carpet and flooring.

Details on the fabrication of the vinyl carpeting have not been released, but the material consists of a layer of raised vinyl pile on a cotton mesh backing (200 nubbins per sq. in.). The material is produced in rolls 72 ft. long and 54 in. wide, and can be cut to smaller sizes and various shapes. It can also be joined to another vinyl carpet by cross-seaming, which involves the application of an adhesive along with a strip of Mylar tape.

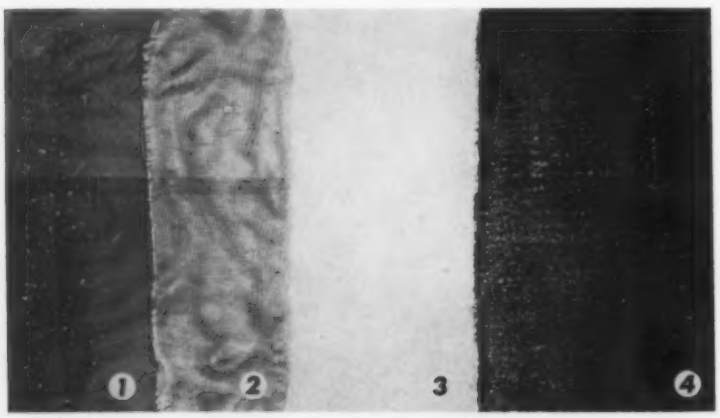
The carpeting is available in red, white, rose beige, turquoise, apricot,



**NEW VINYL CARPETING** shown in typical indoor installation. Material is said to be durable as well as resilient, and is available in eight colors.



**CLOSEUP VIEW** of vinyl carpeting shows raised pile pattern. Material contains more than 200 raised vinyl nubbins per square inch.




**CONSTRUCTION OF NEW BUILDING COMPONENT:** 1—Conventional decking or side paneling (here plywood); 2—fibrous glass cloth; 3—epoxy resin and hardener; and 4—surfacing of mineral granules of desired color.

# Prevent shipment DAMAGE TO PACKAGED METAL PARTS with Spray foam plastisols

**as foam, it serves as safety padding and cushioning . . . also suited to insulating and sound-deadening applications.**

Springy, durable abrasion-resistant, *Sterilkote Plastisol Series No. 410 is a vinyl chloride based protective coating designed as a Spray Foam Plastisol. These coatings are widely used for packaging metal parts to prevent damage in shipment, and are effective for insulating and sound-deadening applications. Plastisol Series No. 410 can be formulated to produce varying degrees of foam densities, from a soft to a firm foam.

Supplied as a free-flowing liquid it converts to a tough, resilient, inert, foam protective coating. It is supplied as follows: Medium viscosity, available in all colors, solids content 95-100%, fusion temperature of 350°F. to 400°F. and possesses excellent flexibility.

A coating of 30 mils can be secured. The film thickness after baking becomes two to four times the amount applied. Conventional Spray Equipment is satisfactory for applying this coating. The ovens can be any conventional gas or electric units; also, infra red lamps or strip heaters can be used. Special Bradley-Vrooman plastisols and organosols can be supplied for dipping, slush molding, roller coating, spraying and casting. In addition, the full services of our laboratory are at your disposal. When requesting further information, mention your intended application.

**BRADLEY & VROOMAN CO.**
1631 S. Dearborn St. • Chicago 16, Ill.


green, gold, and charcoal colors. Retail price for the material is $6.95 per sq. yard.

### Epoxy die cuts cost 87%

Nose cones are explosively formed from cone shaped aluminum blanks by a single shot in a laminated epoxy-faced die. Cone is used for

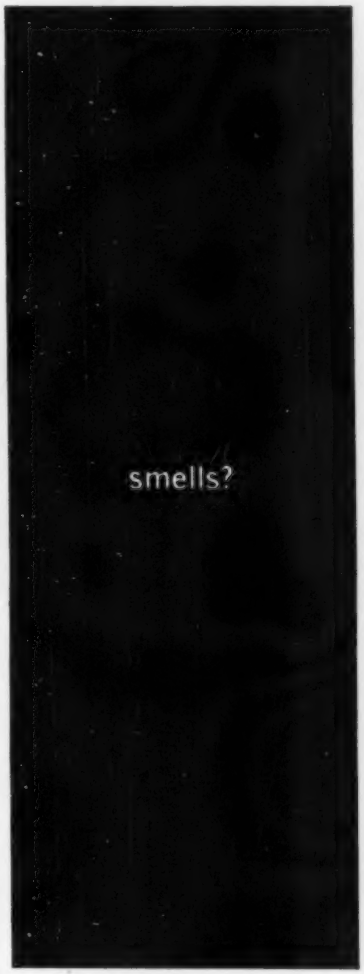
aircraft engine pods. Forming is to tolerances of 0.002 inch. According to Ryan Aeronautical Co., San Diego, Calif., the part costs $15. Explosive forming made it possible to dispense with a series of drop hammer dies, welding fixtures, shaping mandrel, and final surface finish—at a production cost of $131 per part. The Ryan-laminated epoxy dies used formulations based on Shell resins.

### . . . And in brief

• Liquid proportioner molded of Tenite butyrate plastic by Amos Molded Plastics, Div. of Amos-Thompson Corp., Edinburg, Ind., disperses medication into water for poultry and livestock. Designated Auto-Medic, the unit holds 2 gal., will treat up to 500 gal. of water without refill.

• Injection molded letters from Scott Plastics Co., Palmetto, Fla., are available in high-density polyethylene, polystyrene, acrylic, and butyrate for such uses as office identification and outdoor signs. Letters, with exception of butyrate, can be mounted by means of a Teflon-based, pressure-sensitive adhesive. A range of letter sizes and colors is provided, depending upon the plastic letter material specified.

• Pressure-sensitive rayon-acetate label provides good grip on hard-to-handle surfaces, such as are found in many molded plastics. These "fabric" labels can be printed, typed, and written on. Offered by Avery Label Co., Monrovia, Calif., under the designation FAB P-5.—End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# LITERATURE

Write for these publications to the companies listed. Unless otherwise specified, they will be sent gratis to executives who request them on business stationery.

**"Metallizing of Plastics"** by *Harold Narcus.*

Published in 1960 by the Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y., 208 pages. Price: $5.50.

Covering all the known methods used in metallizing plastics, this book deals with actual production procedures, formulations, and techniques. Included are electrodeposition (plating), vacuum metallizing, cathode sputtering, silver spray, and other miscellaneous methods. The physical characteristics of the metallized coating and test methods are also discussed. The book closes with a discussion of recent developments and expected future potential. Aside from decorative metallizers, engineers interested in putting conductive coatings on plastic surfaces will also find useful, practical information in this book. A worthwhile addition to the Reinhold Plastics Application Series.—*G.R.S.*

**"Resins—Rubbers — Plastics Yearbook 1959."** *Edited by H. Mark, E. S. Proskauer, and V. J. Frilette.*

Published in 1960 by Interscience Publishers Inc., 250 Fifth Ave., New York 1, N. Y. 1568 pages. Price: $60.00.

Originally published as "Resins-Rubbers-Plastics Literature Service Series II, Vol. XIII, Issues 1–12," this book contains abstracts of papers dealing with the properties and behavior of resins, rubbers and plastics published in domestic and foreign journals in 1959. Mainly of interest to the polymer chemist, the abstracts presented differ from the conventional abstracts in that they are more extensive and contain original data, graphs, charts, photographs, etc. Documenting the published progress being made in polymers throughout the world, it is most useful as a reference to engineers and chemists with a serious interest in polymer research.—*G.R.S.*

**"British Plastics Year Book—1960"**

Published in 1960 by Iliffe & Sons Ltd., Dorset House, Stamford St., London SE1, England. 696 pages. Price: 43s 9d ($6.00).

Divided into nine sections, this thirtieth edition has been revised to include names and addresses of almost 7000 firms associated with plastics in the United Kingdom and around the world. Classified lists include manufacturers and suppliers of materials, finished products, and equipment; and trade and proprietary names. Additional sections give a Who's Who in the plastics industry in the U. K., and a set of tables points out comparative properties of plastics materials.

**Textile Fiber Materials for Industry** describes the major ingredients; physical, mechanical, thermal, electrical, acoustical, optical, and chemical properties; etc., for Fiberglas; explains its variety of uses; compares its properties with Dynel, Verel, Dacron, Kodel, polyethylene, polypropylene, saran, Vinyon, Teflon, Darvan, cotton, wool, viscose, cuprammonium, Fortisan, acetate, Arnel, nylon, Orlon, Acrilan, and Zefran; mentions the forms available —yarn, mat, roving, scrim, chopped strands and milled fibers, and fabrics and tapes; discusses its fabrication; etc. 52 pages. *Owens-Corning Fiberglas Corp., Toledo 1, Ohio.*

**Dapon resin-saturated papers.** Recommended materials, equipment, and production techniques for users of Daponite laminating surfaces—based on Dapon diallyl phthalate resin—for hardboard, particle board, and plywood. 24 pages. *Dapon Dept., Food Machinery & Chemical Corp., 161 E. 42nd St., New York 17, N. Y.*

**Fibrous glass-polyester insulation.** Specifications, applications, hand sample of flat sheet decorated with decal, etc., for six grades of Insul/Struc fibrous glass polyester laminates. 4 pages. *Cincinnati Development & Mfg. Co., 5614 Wooster Pike, Cincinnati 27, Ohio.*

**Industrial chemicals.** Chemical composition, general properties, distillation, shipping instructions, etc., for a line of cresols, xylenols, and cresylic acids, including meta para cresol, resin, and 3,5-xylenol grades developed specifically for the plastics industries. 14 pages. *Productol Co., 417 S. Hill St., Los Angeles 13, Calif.*

**Research in Plastics** covers research and development work with reinforced plastics in such areas as structural members; re-entry vehicles; high temperature insulation; polymer coatings; and mechanical, electrical, as well as environmental testing. Bulletin 158. 8 pages. *CTL, Division of Studebaker-Packard Corp., 1240 Glendale-Milford Road, Cincinnati 2, Ohio.*

**Plastic drain and sewer fittings.** Sizes, types, applications, and installation data for a line of plastic drain and sewer fittings. 6 pages. *Sloane Mfg. Co., 7606 N. Clybourn Ave., Sun Valley, Calif.*

**Plastic containers.** Specifications, uses, prices, etc., for a complete line of square, rectangular, round, hinged, and an assortment of plastic containers. 16 pages. *Bradley Industries, 1650-58 N. Damen Ave., Chicago 47, Ill.*

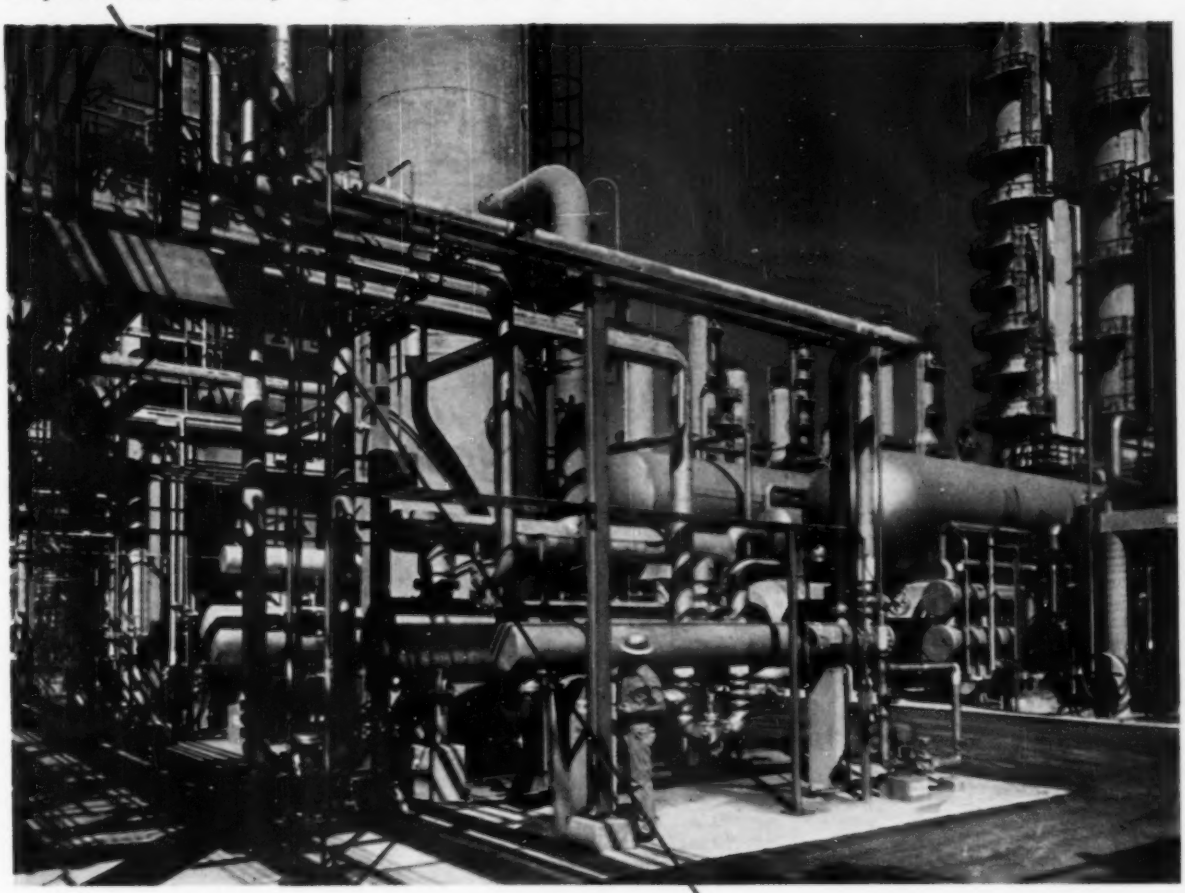
**Thermocouple assemblies.** Specifications, prices, dimensions, etc., for over 100 complete thermocouple assemblies. Included are those insulated with silicone-impregnated asbestos and fibrous glass, flexible PVC-covered armored tubing, etc. Catalog G100-1. 42 pages. *Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne and Windrim Aves., Philadelphia 44, Pa.*

**Annealing Chamber Improves Optical Properties** explains how a new technique improves optical properties of blown polyethylene film; describes how clarity and gloss can be improved. 4 pages. *U. S. Industrial Chemicals Co., Div. of National Distillers & Chemical Corp., 99 Park Ave., New York 16, N. Y.*

**Production facilities.** Bulletin describes the research and development facilities for the production of laminated plastic and vulcanized fibre, as well as for their fabricating into finished parts. 10 pages. *Taylor Fibre Co., Norristown, Pa.*

**Insulating materials.** Description, uses, thermal conductivity, general recommendations for thickness, sizes, features, etc., for Mono-Kover one-piece pipe insulation, which is composed of incombustible, moisture-resistant mineral fibers bonded with phenolic resin. Similar data on Fine-Fyber, a long fibered, featherweight thermal and acoustical insulation made of incombustible, moisture resistant mineral fibers bonded with a thermo-setting resin **(To page 164)**

# Important Quality Improvements in *Petro-Tex n-BUTENE-1*



Deliberate removal of undesirable olefins from our commercial production of Petro-Tex n-Butene-1 has resulted in a very substantial quality improvement over the past two years.

Our specifications guarantee a minimum purity of 95% Butene-1, maximum water content of 100 ppm *and no butadiene whatsoever.* But a typical analysis of our commercial production as shipped is: Butene-1 *98.0%;* Isobutylene *0.6%;* Butene-2 *0.8%;* n-Butane *0.6%* and water 20 ppm. In most chemical reactions, these impurities are not detrimental.

Petro-Tex n-Butene-1 is now being used by important linear olefin polymer producers. As a highly reactive alphaolefin, it undergoes a wide range of oxidation, hydration, alkylation and oxo-process reactions which commend study of its use for n-butyl alcohol, butylene oxides as well as various copolymers and petrochemicals.

We invite inquiries on Petro-Tex n-Butene-1 and

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**BUTADIENE** **DIISOBUTYLENE** **TRIISOBUTYLENE**

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# "Foster Grant has a new, low price for Nylon-6, and here's why," *says Joe Foster*

WE DIDN'T WAIT for Nylon-6 to become a large volume molding resin before we reduced the price. We simply did what we believed in—lowered the price of our 60 series of Fosta® Nylon resins from $1.18 per pound to as low as *$.98 per pound*. Now, no one responsible for the design, development and manufacture of molded products can afford not to consider Nylon-6 as a basic, efficient and profitable fabricating material.

Experience both as raw material suppliers and proprietary molders tells us that Nylon-6 has a wonderfully promising future. For example: Housings for portable electric radios, for home electric appliances, for hand power tools and important components such as gears, rods, tubes and plates and countless other molding applications haven't even been tapped yet.

Nylon-6 is one of the *great* molding resins. It provides toughness, non-flammability, superb molding

ease, abrasion-resistance and colorability by pigmenting or dyeing. It also possesses good electrical properties, is impact-resistant, light-stable, self-lubricating, flexible and has excellent heat stability. In short, Nylon-6 can do almost anything a molded product might require.

Our confidence in Nylon-6 is supported further by what certainly is a trend toward still lower material prices. One obvious indication is that within the last three years, caprolactam monomer—the basic ingredient of Nylon-6—has come down more than 20%. The next two or three years should bring even lower caprolactam prices and wider and more varied use of Nylon-6 in end product applications everywhere.

Faith in the future of Nylon-6 prompts us to take this major step in making this great molding resin more available than ever before to the plastics industry. We would like to make Fosta Nylon more familiar to you by sending you our completely new price list and brochure and by discussing your molding operation and Nylon-6 requirements with you. Just call or write Foster Grant, Leominster, Mass., KEystone 4-6511. We're ready to work with you and your staff right now!

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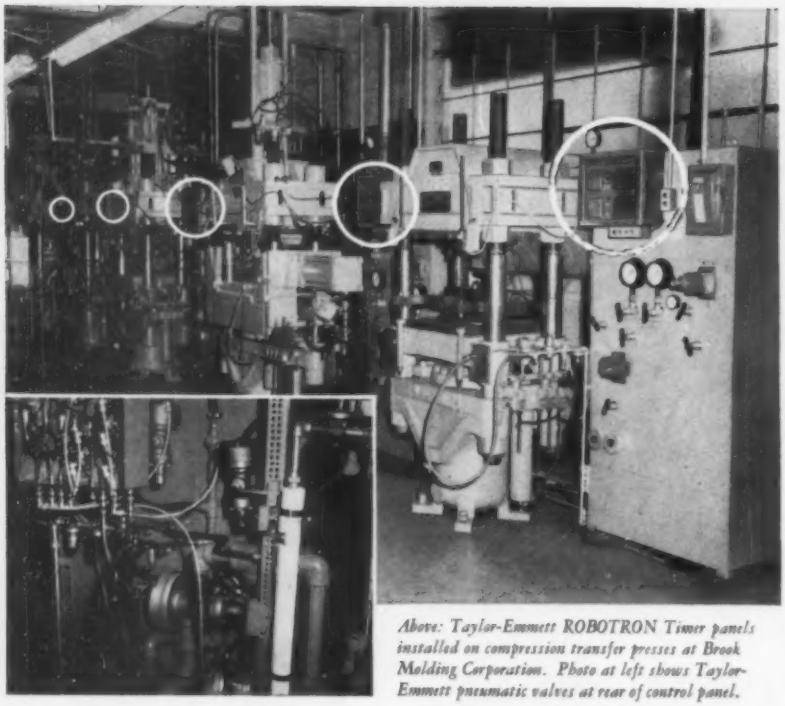

*Above: Taylor-Emmett ROBOTRON Timer panels installed on compression transfer presses at Brook Molding Corporation. Photo at left shows Taylor-Emmett pneumatic valves at rear of control panel.*


"TAYLOR-EMMETT Valves and ROBOTRON* Timers give us uniform performance cycle after cycle!"

"Through their use", says Mr. F. Reed Estabrook, Jr., President of Brook Molding Corporation, Norwood, Mass., "we get instantaneous control over time, distance, speed and pressure, — variables which determine the success or failure of a production molding cycle."

Brook Molding produces camera and projector parts, components for electrical switch-gear, missile parts, electronic equipment and timing devices, processing equipment parts. To make such a wide variety of shapes and sizes of product, in all types of materials, requires extremely rapid changing of molding cycles for efficient operation. "Our Taylor-Emmett valves and timers permit resetting to new molding cycles in a matter of seconds. Compression presses do double duty as transfer presses—a versatility due in large part to these Taylor-Emmett instruments", adds Mr. Estabrook.

Taylor-Emmett valves and timers are sold and serviced by Taylor Instrument Companies. See your Taylor Field Engineer, or write Taylor-Emmett Controls, Inc., Akron, Ohio, or Taylor Instrument Companies, Rochester, New York and Toronto, Ontario.

*Trade-Mark

Taylor-Emmett Controls, Inc.
A subsidiary of Taylor Instrument Companies


binder. Brochure also contains data on other insulating materials. 24 pages. *Baldwin-Ehert-Hill Inc., 500 Breunig Ave., Trenton 2, N. J.*

**Mask washing machine.** Models. available, features, etc., for a line of machines for high pressure spray washing of paint masks, which are said to remove up to 20 wet coats in 20 seconds. 2 pages. *Conforming Matrix Corp., Toledo Factories Bldg., Toledo 2, Ohio.*

**How to Design and Prepare Tanks for Lining.** Wall chart deals with Do's and Don'ts, with schematic drawing to illustrate each. 1 page. *Protective Coatings Div., Metalweld Inc., Scotts Lane and Abbottsford Ave., Philadelphia 29, Pa.*

**Polyethylene in powder form.** Technical bulletin explains where and how Microthene, a polyethylene in powder form, can be used. 8 pages. *U. S. Industrial Chemicals Co., 99 Park Ave., New York 16, N. Y.*

**The Significance of the Food Additives Amendment of 1958 to the Food Packaging Industry** discusses 1) regulations governing exemption from the law; 2) approval procedures for food additives; 3) the status of printing inks as food additives; 4) limitations in the use of printing inks and other packaging materials; 5) violations and their treatment; 6) summary of the law for printers; and 7) how to comply with the law. 14 pages. *Claremont Pigment Dispersion Corp., 39 Powerhouse Rd., Roslyn Heights, N. Y.*

**Evaluation of Architectural and Decorative Materials** investigates the various tests available for structural plastics; floor, wall, and ceiling coverings; cementitious materials; etc. Data also include specifications, acoustical and performance testing of new materials. 8 pages. *Foster D. Snell Inc., 29 W. 15th St., New York 11, N. Y.*

**Molded polyester switch housings.** Case history report on how housings made of Thermaflow, a reinforced polyester molding compound, produced a new line of speed-responsive switches said to be more compact, versatile, and maintenance-free than its metal predecessors. 4 pages. *Atlas Powder Co., Chemicals Div., Wilmington 99, Del.*

**PE protective tape coatings.** Sizes, colors, prices, specifications, etc., for a line of polyethylene protective tape coatings. 6 pages. *Kendall Co., 309 W. Jackson Blvd., Chicago 6, Ill.*—**End**

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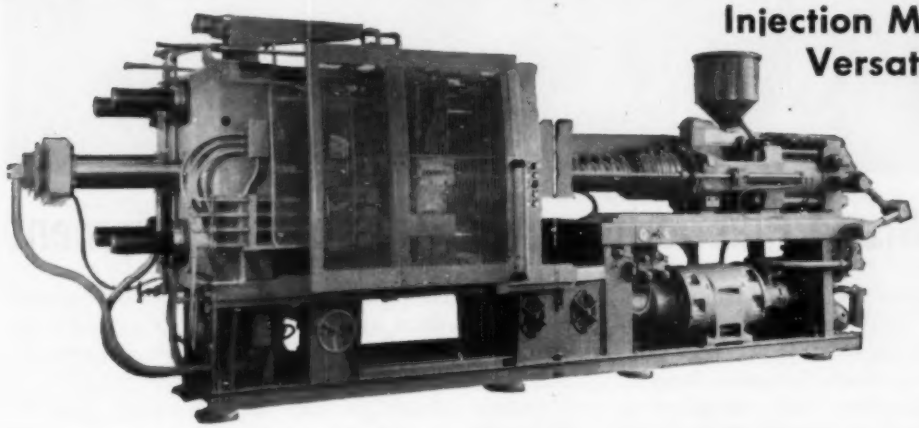

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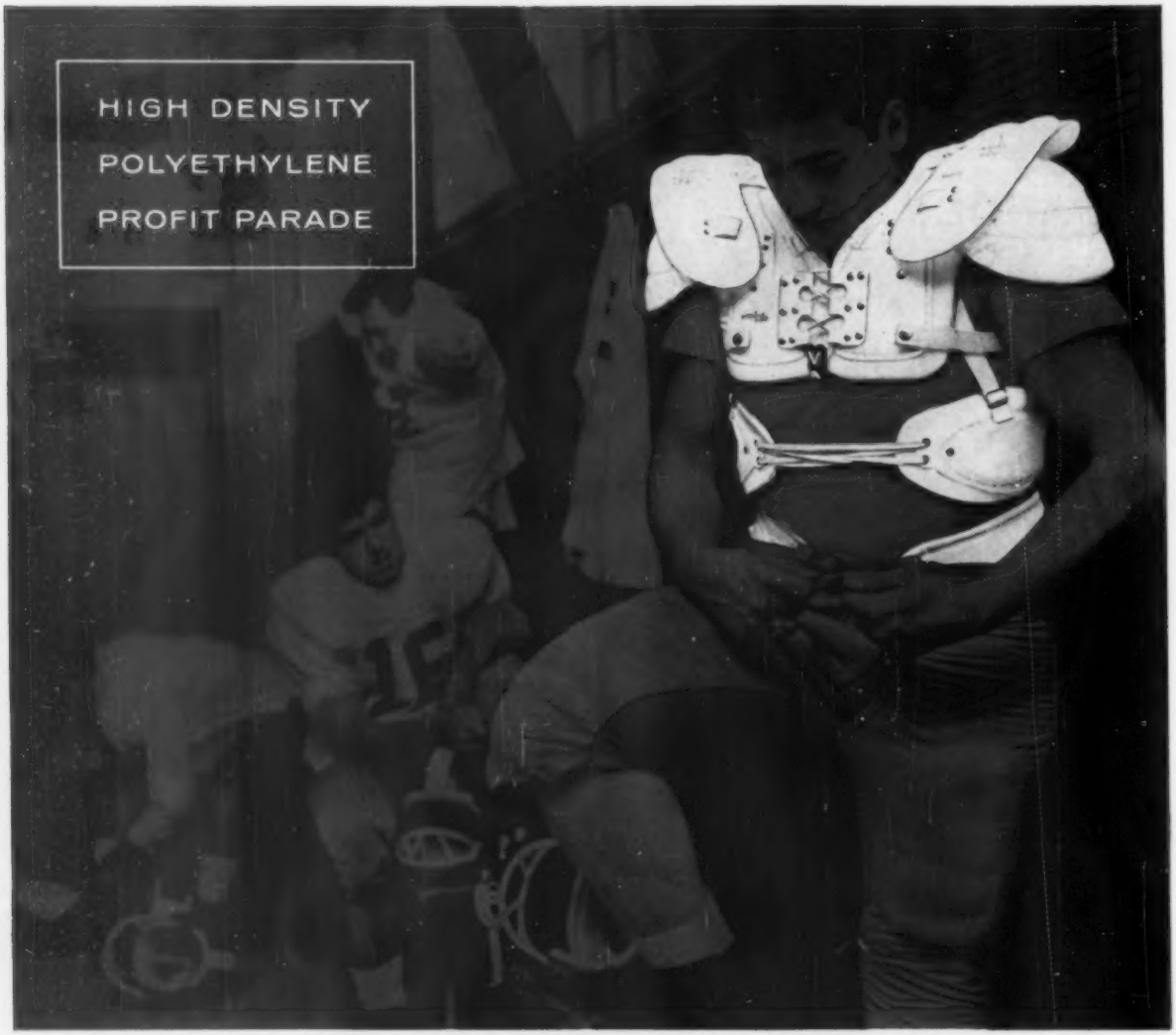



# Sheet From Grace Plastic Improves Protective Equipment

The 1960 football season will see a major improvement in protective equipment, resulting from the combined ideas of the Panelyte Division of St. Regis Paper Company and Rawlings Sporting Goods Company. Panelyte, a leading extruder of thermoplastic sheet, recognized the selling advantage which could be obtained by improving the impact strength, among other properties, of plastic sheet by using Grex high density polyethylene. Rawlings, a customer of Panelyte, was quick to take advantage of these properties by using sheet made from Grex to improve their protective football equipment. The end result is the Crusader brand shoulder, hip and rib cushions now being introduced by Rawlings.

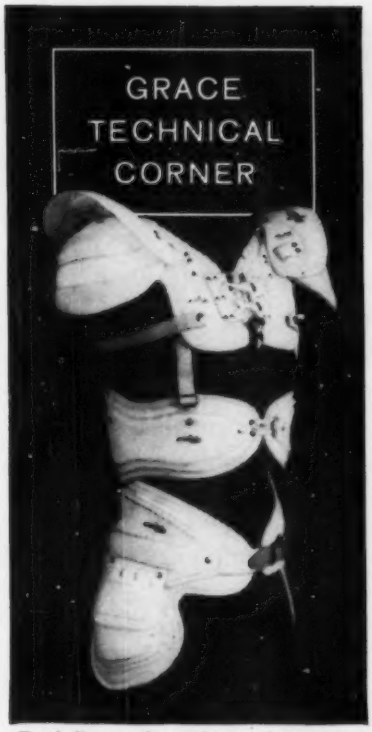
The parts of this redesigned protective equipment are many times stronger than the fiber used in conventional equipment. They are flexible enough to provide increased shock absorption and better body fit. They show less splitting or cracking than fiber, are impervious to perspiration and are unaffected by temperature changes.

Product advantages such as these—made possible through the use of high density polyethylene—are paying off for both Rawlings and Panelyte. Advantages of your product using this Grace plastic could be equally profitable.

Find out exactly what high density polyethylene offers for products in your field by calling in the experts. Grace has the production facilities, technical service and experience to help put your new product in the Grex profit parade. Everyone says we're easy to do business with.

*Grex is the trademark for W. R. Grace & Co.'s Polyolefins.*

W.R. GRACE & CO.
POLYMER CHEMICALS DIVISION
CLIFTON, NEW JERSEY




**Football protective equipment demonstrates rigidity and impact strength of Grex**

How strong is Grex high density polyethylene? According to the notched Izod test its impact strength ranges from 1 to 12 ft.-lb. per inch notch, depending on resin grade. A more practical way to assess the strength and rigidity of Grex is to look at products made of this plastic. Rawlings football protective equipment is one good example. Shoulder, rib and hip cushions are subjected to extremely rugged conditions of use. Where other suitably rigid materials crack, split, shatter or break on impact the new Grex parts are unaffected. There are many other equally dramatic examples.

*Milk delivery cases.* New cases molded of Grex stand up under rough treatment in the dairy and along the delivery route. Furthermore, they do not become brittle even at temperatures as low as –160° F.

*Boat bumpers.* Boat bumpers made of Grex provide all the strength necessary to withstand repeated impact and abrasion at the landing dock. In addition, they are unaffected by salt water.

*Shipping containers.* Banana boxes as well as potato chip shippers are made of Grex. In both cases, rigidity and impact strength are essential for protecting easily damaged foodstuffs. Increased trippage and reduction in product loss make these competitive in cost with conventional containers.

*Other examples.* Safety helmets, fishing tackle boxes, tote boxes for in-plant use, lids for garbage cans and caps for gas cylinders are all made of Grex to obtain the strength and rigidity needed. How about the product you currently have in the works? If you believe it is an application for Grex, now's the time to contact:

Technical Service Department
W. R. Grace & Co., Clifton, New Jersey

## New Machinery

*(From pp. 50-56)*

through a chain to the barrel shaft. The drive is easily accessible for maintenance. *Tumb-L-Matic Inc., St. Mary's St., Stamford, Conn.*

### Automatic parts decorator

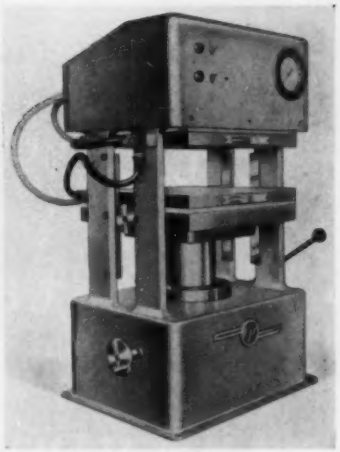
Application of paint and dial fillers to depressed markings, in plastic parts with subsequent wiping and polishing, can now be accomplished at rates up to 2000 pieces/hr. by one Model FWP-40 automatic wipe-in machine. It can be loaded with parts, such as control knobs and dials, which are fed to the masking

**CONFORMING MATRIX**
Model FWP-40 automatic wipe-in machine, showing spray station at left and part mounts on indexing train (center of photo).

station for application of the filler by automatic spray guns. The next station pre-wipes the excess filler while it is still wet. Force drying after the pre-wipe can be used before indexing under the polishing head. Unit is capable of indexing 3000 cycles/hr. and is completely adjustable. Installation requires exhaust facilities, compressed air and electric power source. *Conforming Matrix Corp., 364 Factories Bldg., Toledo 2, Ohio.*

### Hydraulic press

Used for molding, laminating, or testing of plastic materials, this KM 75-ton press has 19-in. square platens, which are electrically heated and are also designed for steam heating or water cooling. A Calrod heater cast in the platen operates at 230 v. a.c., 3 phase, and produces 4000 w. power. A combination of Thermoswitch and mercury relay accurately controls the platen temperature to 600° F. The unit has a four-column welded steel frame.

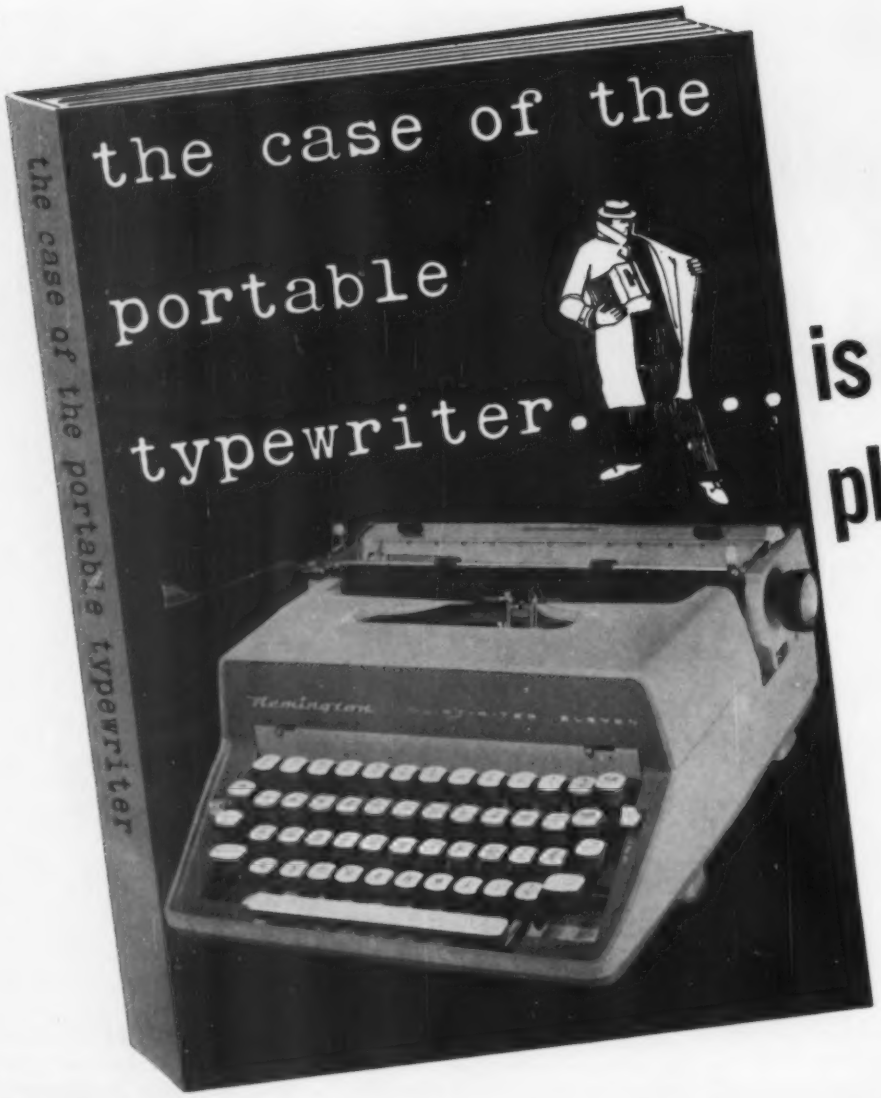


**KINGSBACHER MURPHY**
KM-75 hydraulic press, showing manual model with pumping lever visible at right of the press and pressure release wheel pictured at the left of the base.

Maximum daylight opening between platens is 11 inches. A removable adapter is standard equipment, which allows for a daylight opening from zero to 6 in. or from 6 to 11 inches. A variety of hydraulic units is offered for closing platens and raising pressure. Both manual and motorized powered pumps are available for this press. Special pressure test gages, heat control units, and a number of other accessories are also available. *Kingsbacher Murphy Co., 9830 Bellanca Ave., Los Angeles 45, Calif.*

### Automatic indexer

The Thermatron Automatic Indexing Unit is used in the manufacture of a variety of vinyl items, including binders, bookcovers, etc. The unit automatically feeds a roll of material through cutting, folding, welding, filling, punching, and embossing stations to either a discharge bin, a rewind roller, or onto a conveyor, program-timed to the action of the overall equipment. The length of index is adjustable, as is the material width. Standard units can take roll widths up to 36 in., with an accuracy of approximately $\pm$ 1/64 in., depending on the material being processed. Multiple rolls of material can be fed simultaneously. Tensioning devices with adjustable guides guarantee continuity and uniformity. The unit, while standard in component stations, is generally custom designed to the particular production for which it is required. *Thermatron Division of Willcox & Gibbs, 214 West 39th St., New York 18, N. Y.*—**End**




# ...is now all plastic

The assignment: "Track down a light, strong, attractive housing for a portable typewriter." It took two years of work by a whole force of highly-trained investigators before the case was finished, but the results paid off.

Many materials were checked out, but the solution to the problem was found in the use of plastic. It led to the development of a strong, smartly-designed, two-tone, all-plastic portable typewriter housing that is winning wide acclaim... and sales. With over a million portables sold yearly, the sale of plastics takes another big step upward. And with the increasing use of plastics in building materials, appliances, furniture, luggage, automotive equipment and packaging, it's easy to understand the billion-pound growth of plastics last year (to a total of 5½ billion pounds).

Investigate this market! Your clue to extra sales lies in the fact that the processing of plastics requires machines, motors, tools, dies and a host of supplies and services for making, molding and finishing plastic products. And your best lead for capturing your share of the market lies in the use of MODERN PLASTICS... the dominant magazine in the field, with more editorial matter, more paid subscribers and more advertising than all other plastics publications combined.

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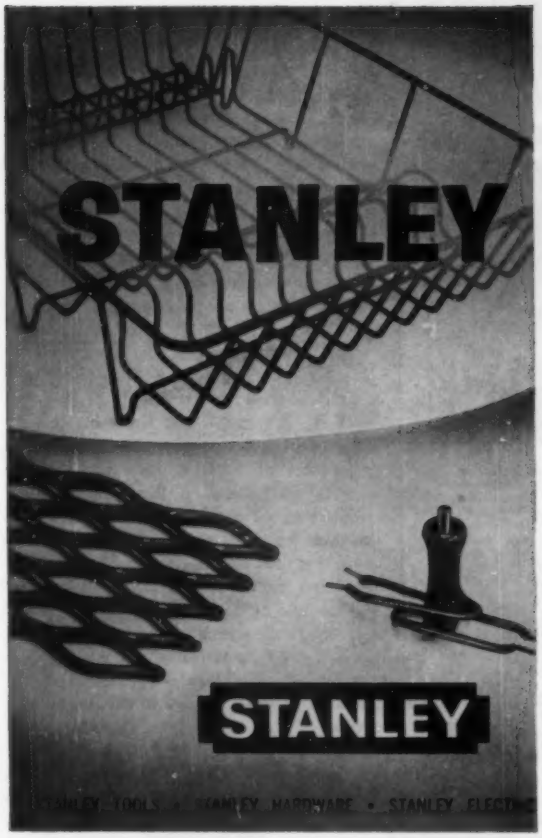


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## Plastics Digest

*(From page 58)*

mers with a solid surface. This is due to the fact that wetting of a solid surface by polymers is connected with change in their molecular configuration, requiring additional expenditure of energy. No analogy may be drawn between the orders of magnitude of the energies of wetting of a solid surface by low molecular hydrocarbons and polymers.

### Testing

*Accelerated aging of vinyl plastic compounds in a modified testing oven.* M. Royen. ASTM Bulletin No. 243, 43-51 (Jan. 1960). The aging properties of PVC compounds are largely dependent on the type and proportion of plasticizers that they contain. Aging is a complex process involving, among other things, an accelerated migration of plasticizers to the surface of the material and subsequent evaporation. Even though the polymer itself remains basically unchanged, this loss of plasticizers causes a distinct change in the properties of the material. Therefore, aging tests are commonly a part of specifications for PVC compounds. Extensive work by many companies has shown that present standard methods for evaluating heat aging of PVC compounds are not reproducible. Work confirming these conclusions is described.

### Chemistry

*Mechanisms of epoxide reactions.* R. E. Parker and N. S. Isaaca. Chem. Rev. 59, 737-99 (Aug. 1959). The reactions of ethylene oxide and its 1,2-epoxide derivatives are reviewed. These compounds react with a large number of compounds to form numerous products; 292 references.

### Publishers' addresses

*Adhesives Age:* Palmerton Publishing Co. Inc., 101 W. 131st St., New York 1, N. Y.

*ASTM Bulletin:* American Society for Testing Materials, 1916 Race St., Philadelphia, Pa.

*Chemical Engineering Progress:* American Institute of Chemical Engineers, 120 E. 41st St., New York 17, N. Y.

*Chemical Week:* McGraw-Hill Publishing Co. Inc., 330 W. 42nd St., New York 36, N. Y.

*Chemist-Analyst:* J. T. Baker Chemical Co., Phillipsburg, N. J.

*Journal of Applied Polymer Science:* Interscience Publishers Inc., 250 Fifth Ave., New York 1, N. Y.

*Kunststoffe:* Karl Hanser Verlag, Leonard-Eck-Strasse 7, Munich 27, Germany.

*NBS Technical News Bulletin:* National Bureau of Standards, Washington, D. C.

*Plastics Technology:* Bill Brothers Publishing Corp., 630 Third Ave., New York 17, N. Y.

*Product Engineering:* McGraw-Hill Publishing Co., 330 W. 42nd St., New York 36, N. Y.

*Space/Aeronautics:* Conover-Mast Publications Inc., 205 E. 42nd St., New York 17, N. Y.

*Vysokomolekuliarnye Soedinenia:* Academy of Science of U.S.S.R., Moscow, Russia.—End

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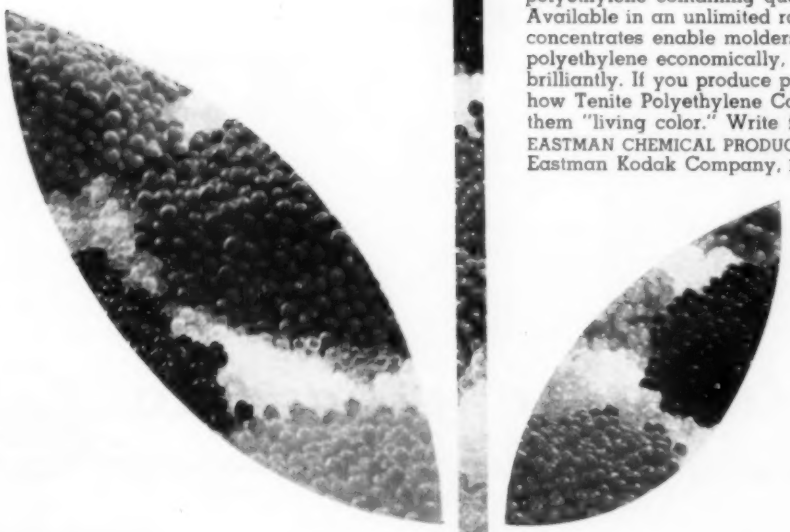

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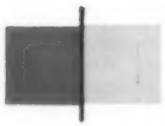

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## Bead board

*(From pp. 97-101)*

strength are the main requirements. Expanded polystyrene board satisfies most of these requirements and has largely replaced cork board, which was once the standard insulating material. Foam glass is expected to remain a competitive material where more complete vapor impermeability and fire resistance are required. The self-extinguishing polystyrene foam board is expected to find wider acceptance when its properties become more generally known. Operating temperatures in cold storage and process space insulation range from coolers (54 to 27° F.), requiring 2 to 3½-in. thicknesses of foam, to sharp freezers (—38 to —61° F.) with 9 to 10 in. of foam. It is thought that polystyrene foam board can capture up to 75%, or approximately 175 million bd. ft. of the potential market by 1964.

In another main category of low temperature insulation—the 50 to 60 million bd. ft. refrigerated display case and cooler market—polystyrene foam has found the competition of fibrous glass, which costs less than half as much, too tough to make any significant impact. The possibility of solvent attack and the polystyrene foam's inability to withstand defrosting temperatures of 300° F. are further limitations. It is anticipated that future changes in insulation materials in this market will be to foamed-in-place urethane, and polystyrene foam will continue to account for between 5 to 10% of the total market.

For pipe and vessels molded expandable polystyrene rather than boards are likely to compete with fibrous glass, foam glass, cork, and possibly sprayed-on urethane; especially as more economical molding methods for beads evolve.

Selling this market depends very largely on establishing ties with contractors, many of whom are also distributors of insulation material. Although architects and customers have the final choice of the material, the contractor's recommendations have a great deal of influence.

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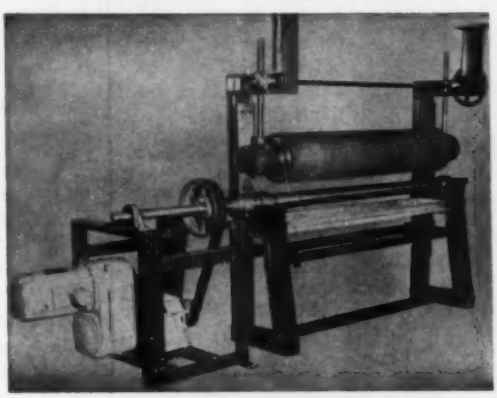

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moisture resistance and non-deterioration when placed on or under the ground make polystyrene foam very acceptable for perimeter insulation of buildings. The foam is placed under the slab foundation to reduce heat loss and act as a moisture barrier. Perimeter insulation is not required in large sections of the country, and only about 20% of all homes have slab foundations. However, polystyrene foam board has about 50% of this 20 million bd. ft. market.

Expanded polystyrene board is used as a combination insulation-plaster base on masonry walls, which represent another estimated 20% of all houses built in the United States. Portland cement is applied to both the wall and the inside surface of the board, which is then bonded to the masonry and coated with plaster. Sometimes the foam is also used as an inexpensive method of finishing and insulating basement walls. These applications are still relatively new, but rapid growth is expected to reach 10 million bd. ft. in the next year, and 25 million bd. ft. in 1964.

Roof insulation is another, but minor market for this material. It has to be laminated or covered to withstand the 300 to 350° F. temperatures of hot bitumen being applied. Laminated board costs about 25% more than standard insulation board. And contractors do not believe that the 1-in.-thick board can support wheelbarrow traffic and rough handling. Current sales are about 4 million bd. ft.—roughly 1% of the market.

**For siding**

One of the fastest growing markets is as a backing for aluminum siding where the foam eliminates condensation, especially in winter. Recent acceptance of polystyrene foam has been so enthusiastic and widespread that the combination of aluminum and polystyrene foam board can be considered as almost a standard panel for the growing sidings market. The entrance of Alcoa into the foam field and the possibility of other aluminum companies establishing captive operations will give further impetus to this market. Current sales are es-

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timated at 30 million bd. ft., with an anticipated growth to 70 to 80 million bd. ft., representing 50% of the aluminum siding market.

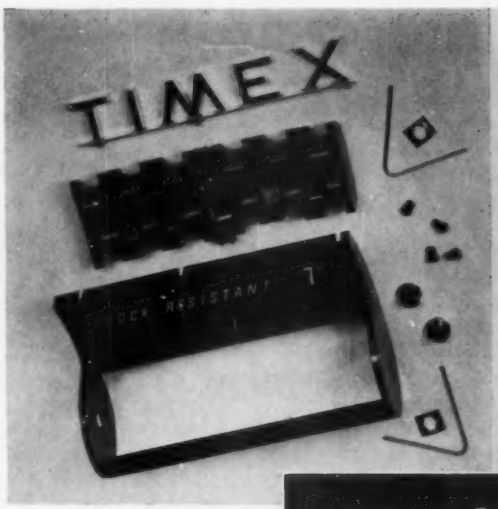
Other building applications include industrial panels, metal building insulation, wall board, ceiling tile, prefab house panels, etc. The panel market is still in its very initial stages, but several large suppliers of building materials and facings for sandwich panels are experimenting with various types of foam cores. Toyad Corp., Latrobe, Pa., a custom molder of bead board, specializes in custom lamination and coating of foam for a variety of end uses. General Foam Plastics Corp., Portsmouth, Va., in addition to the companies mentioned, is developing diversified markets.

**Insulation market**

Building supply houses and roofing contractors are the main channels of distribution for these materials, but architects determine product specification and their acceptance of PS foam board enhances this market's growth.

Insulation in all types of refrigerated transportation, especially floor insulation which has to withstand freeze-thaw cycles and spray-cleaning, in addition to carrying loads without losing thickness, has represented a 20-million-bd.-ft. market for polystyrene foam boards. However, recent improvements in urethane foam technology, especially the better insulating efficiency, presents strong competition and it is estimated that sales of polystyrene foam board will decline to around 6 million bd. ft. in 1964.

Many of the flotation markets use molded polystyrene foam instead of board, but it is estimated that 75% of all aluminum pleasure boats use some polystyrene board material for buoyancy of air chamber applications. Other applications include canoe ends, pontoons and buoyancy tanks of life boats, small naval craft, and other miscellaneous small boats. The total annual market in this type of flotation application is around 10 million bd. feet. Polystyrene foam does not participate in the growing reinforced plastics boat market to any extent, because it is affected by the solvent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action of the liquid polyester resin and the temperatures involved during exotherm.

Rafts, floating decks, and marinas have used polystyrene foam boards to a large extent, but the total market for these applications is not expected to amount to more than 4 million bd. feet.

In the packaging field, Styrofoam rather than bead board has so far dominated the market for slab or fabricated items. Beads, of course, have made a large impact wherever molded units could be used. The greater resiliency and lack of flaking or dusting of bead board has recently found a growing packaging market. Several board molders have introduced resilient slab stock as a cushioning material. Armstrong Cork Co., Lancaster, Pa., is intensively promoting its Resilo-Pak, which is available in densities of 0.5, 0.75, and 1.5 lb./cu. ft. The company claims that this low-density foam represents the best packaging cushioning material in terms of energy absorption per dollar and, on that basis, is competitive with cellulose wadding, bonded hair, and other low-cost cushioning materials. Another packaging use is polystyrene foam sandwiched between paper or cartons, such as the material produced by Fome-Cor Corp., Springfield, Mass.

### The industry outlook

Since insulation represents such a large share of the total market for polystyrene foam board, traditional suppliers of such materials, especially of cork, were among the first companies to set up large molding plants. It is estimated that United Cork, Armstrong Cork, and Mundet Cork have a joint capacity in excess of 50 million bd. ft. annually. Gilman Brothers, a former supplier of fibrous insulation, has switched to polystyrene foam, and it is anticipated that similar companies will enter the field as polystyrene foam continues to grow. Building material suppliers and aluminum companies are also likely to establish board molding operations. However, because of the freight factor, good regional markets can be established by companies with more limited capital, but with well established sales outlets. It has been estimated that an investment of $100,000 in capital equipment can produce 20 million bd. ft. per year. A minimum investment for any board molding operation is generally thought to be $200,000, although there are many people in the industry who feel that an investment of $1 million is necessary for equipment, experimental, and research work, and promotion, technical service, etc. The companies who are already established have acquired a thorough knowledge of the building and insulation field, have done much missionary work, and have collected a great deal of important technical data, much of which has been published in technical manuals. Sales of polystyrene foam board are expected to boom, but each molder has to develop his own markets.—**End**

• • •

**For an unusual application of Styrofoam board see p. 156.**

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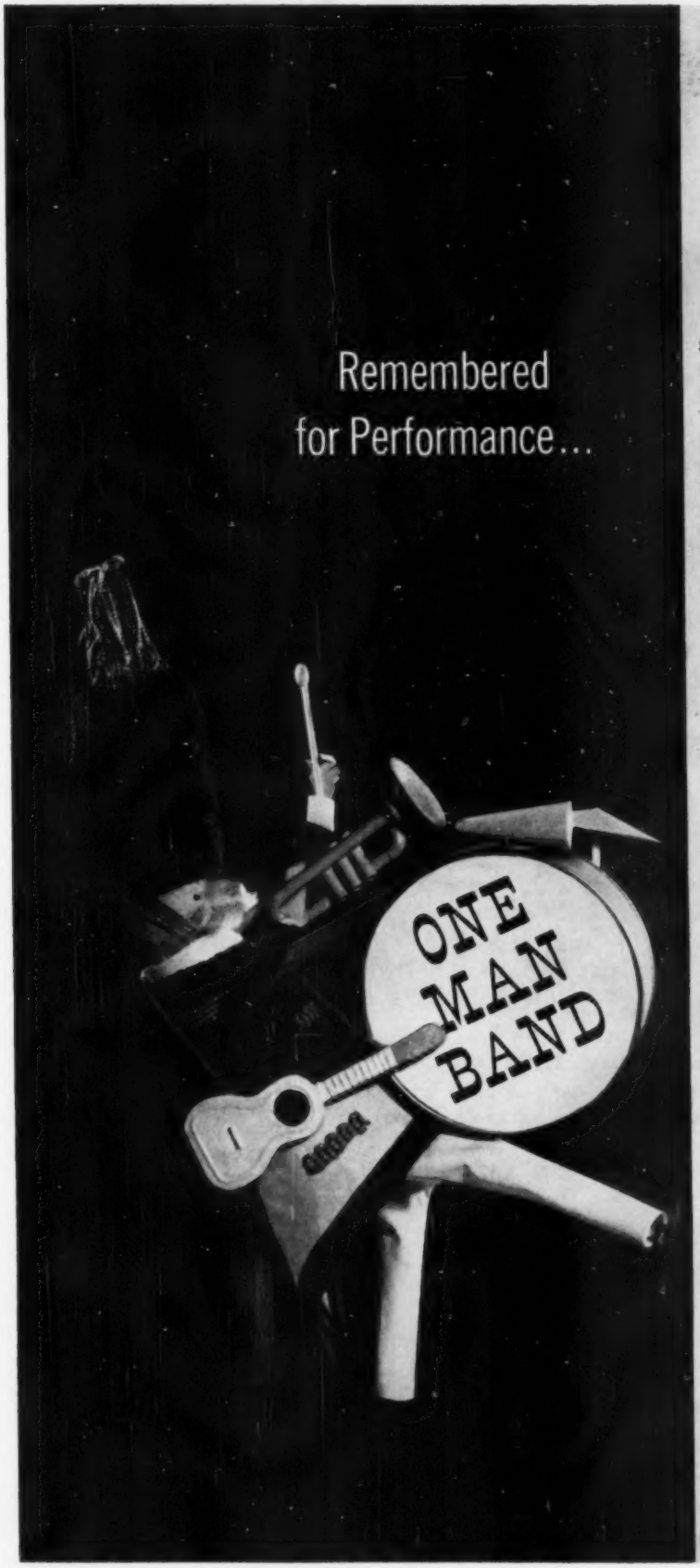


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## Polycarbonates

(*From pp. 102-105*)

polycarbonates have a high melt viscosity and flow characteristics somewhat different from the other thermoplastics, and this factor must also be given consideration. Heated molds (175 to 200° F.) are recommended, and cylinder temperatures in the range of 540 to 625° F. Injection pressures from 12,- to 20,000 p.s.i. (and 30,000 if available) are suggested. Gates should be full round and have a large diameter.

The resin can be dry-colored if it is carefully redried. It is also available in colored form from the material suppliers. In its natural state it is transparent with a slight amber tint. Because of this limitation, it has not been possible so far to develop a pure white color, nor a water white transparent piece.

### Conclusions

In April 1958, when MODERN PLASTICS magazine published the first complete technical article on the new resin, the authors began their story by stating: "In this day of innovations, it takes an exceptional material to register any impact on an industry that is growing as rapidly as the plastics business." They continued to note that polycarbonates promised to be such a material.

A little over two years later, this promise has come close to fulfillment. Industrial end users, industrial designers, and many segments of the plastics processing industry are finding fresh solutions to their problems in the new material. The resin is unique in its combinations of properties. It's going to expand plastics' penetration into many fields which have long been off limits to plastics.

### References

For earlier articles published in MODERN PLASTICS, see:

1. Polycarbonate resin, April 1958, p. 131.
2. First polycarbonate applications, Dec. 1958, p. 96.
3. Working with polycarbonate resin, Apr. 1959, p. 115.
4. Three new cost cutters, Aug. 1959, p. 67.
5. *Modern Plastics Encyclopedia Issue for 1960*, p. 132.—**End**

## Extruding PP films

*(From pp. 111-123)*

smaller extent. When roll temperature was increased to 110° F., the transverse tear strengths of the resins decreased sharply, illustrating the effect of higher roll temperatures and slower cooling.

Although extrusion pressure was not observed to be a major factor in other film properties, transverse direction tear strengths for films of Resin A were found to increase by about 100 g./mil as pressure increased from 1100 to 2400 p.s.i.

**Stiffness.** A Thwing-Albert Instrument Co. Handle-O-Meter was used for an empirical determination of stiffness.

Within the range of densities evaluated, the effect of processing variables was negligible. The water bath method did yield stiffer films than did the chill-roll technique, as shown in data on Resin B in Tables II and IV, pp. 116-117; 122-123, respectively. As mentioned before, the higher orientation of films produced by the water bath method probably accounts for much of this effect on stiffness. It was concluded that generally operating conditions can be varied widely without significant effect on film stiffness.

### Crystallinity, crystallite size

When the size of polypropylene crystals is smaller than 70 Angström units, (Å = $10^{-7}$mm.), measurement of the percentage of crystallinity and crystal size is rather difficult. However, modified procedures can be used to obtain measurements of crystal size down to about 40 Å.

Measurements on water bath film indicated that these films were more crystalline than the more amorphous chill roll films. However, it was observed that when using a low water bath quench temperature of 67° F. when extruding Resin B, the resultant film was more amorphous than chill roll film.

Larger air gaps resulted in lower percentages of crystallinity, while crystallite size and film density data for Resins A and B as a function of processing variables showed no definite trend. Some interactions were **(To page 185)**


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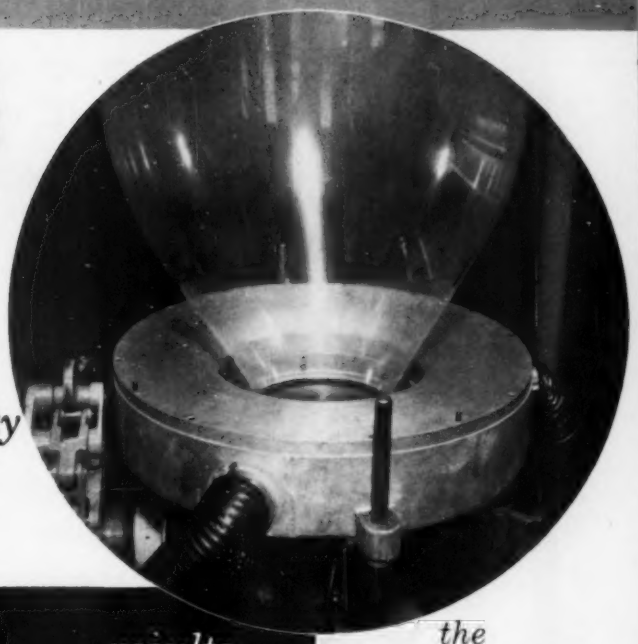
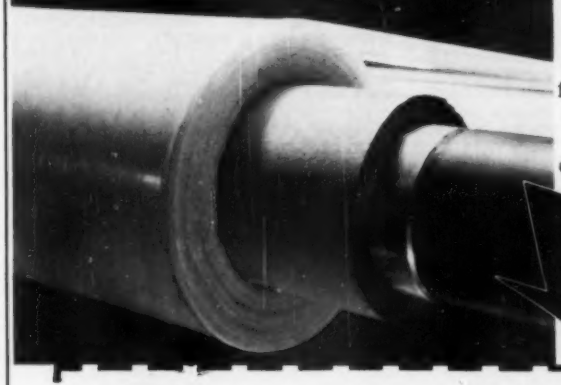


2 *results in product superiority at the wind-up*



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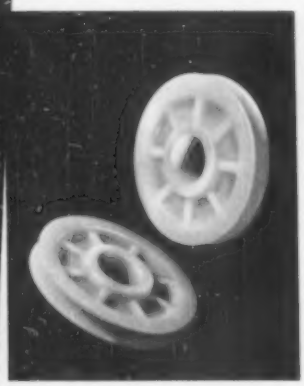

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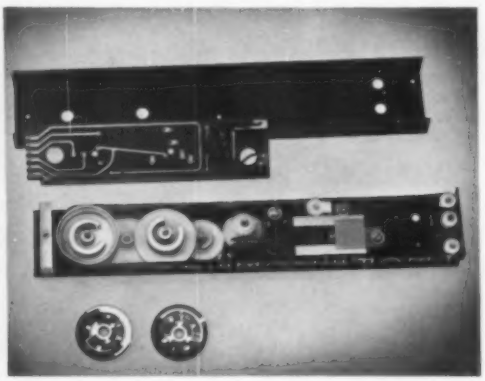
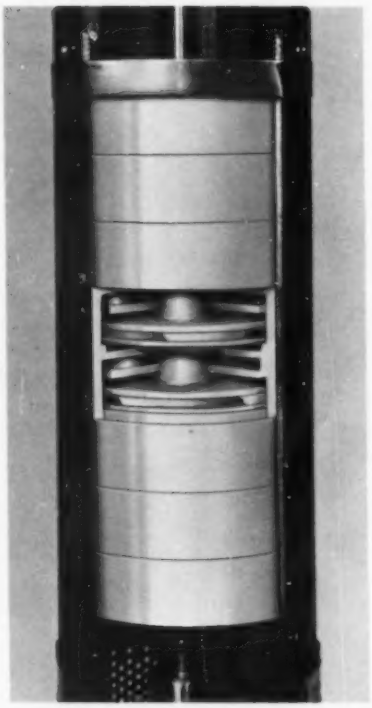


In their Post-Rite® data indicator, the General Railway Signal Co., Rochester, N.Y., uses nine parts of DELRIN, molded by Control Molding Corp. These gears, cams and rollers function as a gear train that guides a printed tape to a view port upon electrical impulse. These indicators must operate without lubrication at high temperatures with minimum maintenance. Only DELRIN could provide the dimensional stability, light weight, low-friction operation required in long-term use.



In an eight-stage submersible pump (two stages shown) precision-molded parts of DELRIN replace brass components . . . making possible improved performance, increased efficiency and a substantial cost saving. The Flint and Walling Mfg. Co., Kendallville, Ind., reports that DELRIN has given superior performance over brass in abrasion resistance and corrosion resistance and the prevention of mineral build-up . . . permits "top pump performance at bottom dollar prices."

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noted during the factorial run on Resin A. Quench temperature was found to have an effect only at high stock temperatures —i.e., high quench temperature increased percent crystallinity. Higher pressures decreased crystallinity at the greater air gap. Crystallite size went up more at the 500° F. than at the 550° F. stock temperature as chill roll temperature went from 80° F. to 110° F. Increased pressure decreased crystallite size only at the higher quench level. Data for Resin B at the 550° F. stock temperature showed constant crystallite size for the two levels of quench temperature and air gap.

The test results indicate that differences are present for various resins. Operation at 550° F. stock and an 80° F. chill roll is preferred, however, due to the higher impact strengths and lower haze readings generally obtained. For Resin A, lowest crystallite size and percent crystallinity are favored by these operating conditions.

**Slip (Coefficient of friction).** Packaging machines need high coefficients of friction (C.O.F.) i.e., values in the vicinity of 0.60 to 0.80. Items like produce bags require low coefficients (0.20 to 0.40) so that the bags will open readily when the contents are to be placed in them. An excessive level of slip would not permit easy stacking of boxes where the film is used as an overwrap—i.e., candy boxes, etc.

The resins evaluated during this study contained no slip or anti-block additives. The C.O.F. increased as resin melt index increased for cast films (Fig. 7, p. 122) but was independent of melt index for films prepared by the water bath up to a value of 15.7 M.I. water bath films, without any additives, had C.O.F. within a 0.40 to 0.60 range and were generally found to have a lower C.O.F. than chill roll films.

Friction levels increased appreciably at the 2½ in. air gap from those produced at the 1-in. span for the chill roll films and, in fact, some blocking was present on films prepared at the 550° F. stock temperature. Blocking did not ever occur during our studies on water bath films, nor on the chill roll runs at the 1-in. gap, unless the stock temperature was excessive—i.e., 570° F. and up. Slip additive studies in the laboratory have proven that polypropylene can be compounded to all levels of C.O.F., regardless of the air gap, depending upon the amount of slip and anti-block agents added.

The effect of the processing variables upon friction is shown qualitatively in Table III.

### Summary

Based on this study of the effects of processing variables on the film, the processing conditions shown in Table V, p. 123, are recommended for the extrusion of polypropylene film. The use of these conditions can be expected to produce films having the properties shown in Table VI, p. 123. However, it should be remembered that marked deviations in processing conditions outside the ranges shown can produce films which exhibit significantly different properties.—**End**


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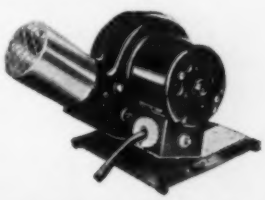

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## Fluidized bed coating

*(From pp. 124-128)*

volume ratio are used. Coating material used contained 20 p.h.r. DOP and did not exhibit suitable flow at 175° C. This resulted in a non-uniform, porous coating, which accounts for the heavier coating recorded for 175° C. as compared to 200° C. on highest surface/volume ratio panel.

### Effects of plasticizer level

The effect of plasticizer concentration and operating temperature on coating thickness is shown in Fig. 5, p. 128. As plasticizer concentration increases there is a corresponding increase in coating thickness. The apparent discrepancy exhibited by the 5 p.h.r. DOP material at 175° C. becomes clear if we consider that, while the coating was thin, the resin pick-up was too heavy to properly fuse and flow at this temperature. This caused an uneven porous coating of abnormal thickness.

The relationship between plasticizer concentration, operating temperature, and post-fusion time is found in Fig. 6, p. 128. Coatings represented here were applied to 2- by 4- by 0.125-in. panels. It is observed that as plasticizer concentration increases, post-fusion time decreases. In addition, operating temperature requirements are lowered. For instance, the highest plasticized dry blend (30 p.h.r. DOP) exhibited satisfactory fusion and flow at 175° C. Operating temperatures much lower than 250° C. are not recommended for the 5, 10 and 20 p.h.r. formulations because of poor fusion and flow of the resin pick-up. Operating temperatures from 250 to 300° C. are required to impart flash fusion and flow of vinyl powder coatings.

### Application

Vinyl fluidized bed coatings closely parallel plastisol dip coatings and can be formulated to provide the chemical and corrosion resistance required for electroplating racks, mixing equipment, valves, and pump parts. Fluidized bed coatings are also especially attractive for wire baskets, decorative and protective claddings for glass containers, auto seat springs, and tool handles.—**End**

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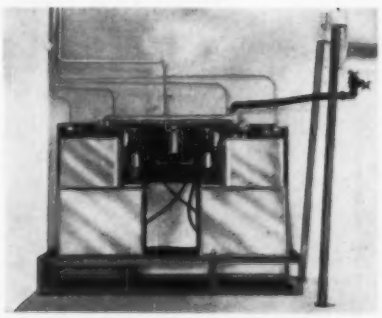

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## Polymeric melts

*(From pp. 133-140)*

observations to the contrary that appear in the listed literature have been discussed.

3. More convincing evidence than heretofore available has been presented in support of the hypothesis that the inlet region of a tube or die is responsible for the irregularities observed in extrudates at the higher shear rates. The variation of this "critical" stress or shear rate with inlet geometry and tube length has been studied in some detail.

4. Variations in the ratio of the extrudate diameter to the die diameter have been studied as a function of both shear rate and the length to diameter ratio of the tube or die.

5. Measurements of the diameters of extrudates obtained from very long tubes (L/D=200) have been used to calculate the normal stress (elasticity) parameters of both polyethylene and polypropylene. Further work is required in this area.


### Acknowledgment

The substance of this work has been supported by the Office of Ordnance Research, Department of the Army.

The authors are indebted to W. F. O. Pollett of W. T. Henley's Telegraph Works Co. Ltd., Gravesend, Kent, U. K., who first suggested the "infinite tube" experiments. E. C. Bernhardt (E. I. du Pont de Nemours & Co.) and E. T. Severs (AviSun Corp.) kindly made available the polyethylene and polypropylene required, respectively. W. Philippoff kindly made a preprint of his paper available at an early date.


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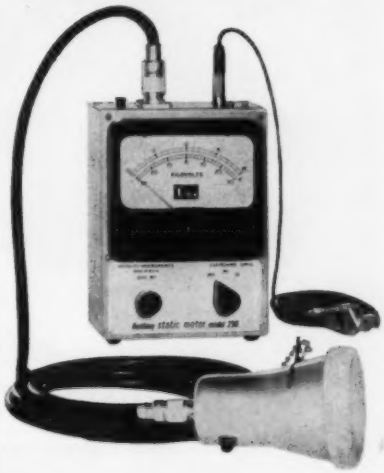

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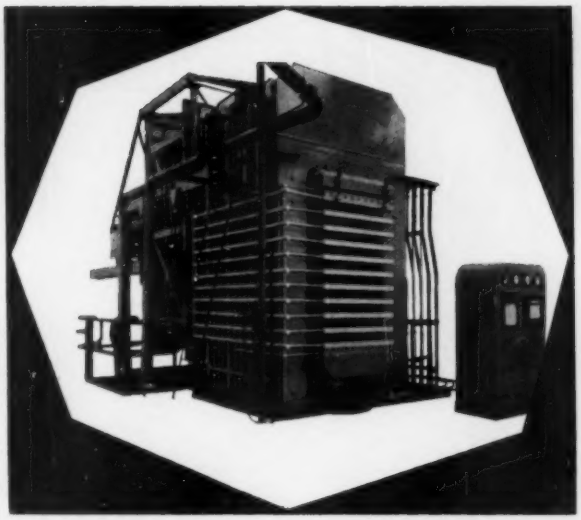

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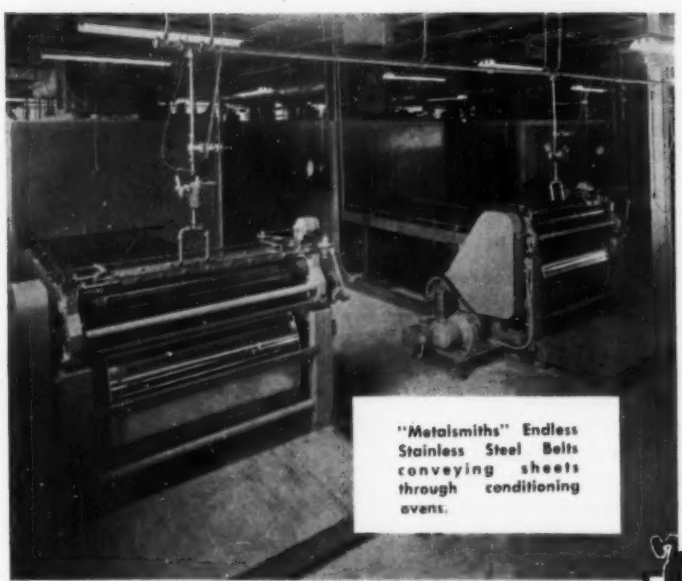

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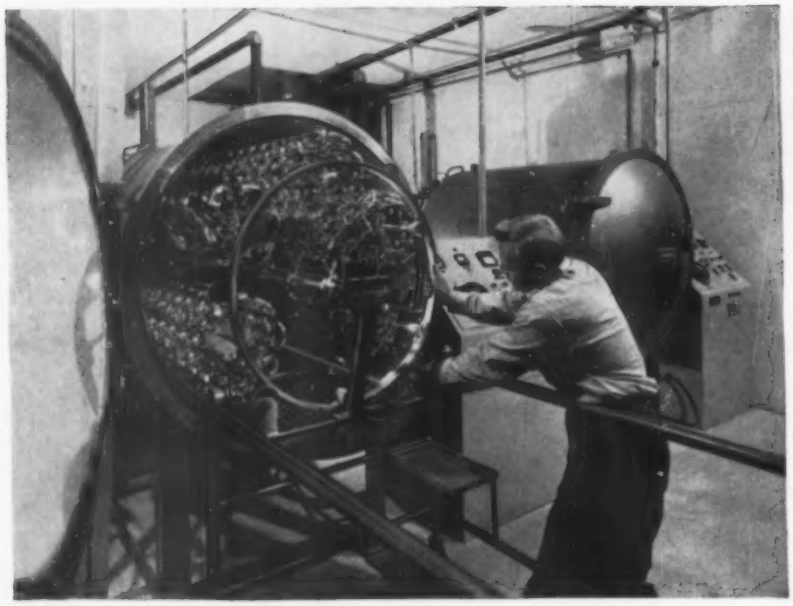

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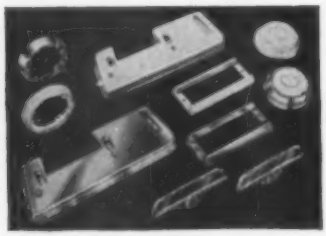

This Stokes 426-3, 48" Vacuum Coater is setting new performance standards in first and second surface metallizing of automotive and appliance components at Welsh Industries. Welsh reports that the high performance pumping system has resulted in a 20% production increase . . . and a 30% reduction in man-hours. Further, *the compact design affords a 10% savings in floor space.* Finally, Welsh profited from substantial savings in initial cost as compared to a comparable, competitive unit.

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## Stabilization

*(From pp. 142-155)*

increase in yield point. This difference is quite difficult to explain, particularly when it is recalled that these polyamides are inherently more heat stable than the 66/610/6 and 66/6-◊/6 nylons before addition of stabilizers. There seems to be no doubt that the piperazine itself is in some way responsible for this deterioration. This is borne out by the fact that reducing the amount of piperazine in a polyamide improves the responsiveness of the polymer to antioxidant-type stabilizers, as was done in the mixed polyamide 66/610/pip-6 by shifting the composition from a 35:30:35 weight ratio to a 65:10:25 ratio.

At this time, a precise explanation for the failure of the piperazine polyamides to respond to antioxidant stabilizers cannot be given. Any one or all of several different factors may be responsible. For example, excessive crystallization during aging in a polymer can cause the physical properties of the polymer to deteriorate. An increase in stiffness and brittleness would certainly be expected under such a circumstance. In fact, careful study of the properties of heat-aged nylon 66/610/6 or 66/6-◊/6 reveals that even in the most stable compositions, there was still a significant increase in stiffness, as shown by large increases in the yield point. That such changes do occur is shown by the X-ray diffraction diagrams of Figs. 2, 3, and 4, p. 146. They illustrate the change in crystallinity undergone by three of the investigated polyamides, nylons 66/610/6, 66/6-◊/6 and 66/610/pip-10. In fact, a certain relationship can be said to exist between the extent of crystal growth and retention of properties during aging. Heat-aging data for these samples are listed in Table VII, p. 154; they show that nylon 66/6-◊/6 develops some stiffness, whereas nylon 66/610/6 remains a little more flexible. The X-ray diagrams show that the latter polymer remains essentially amorphous during aging, with nylon 66/6-◊/6 developing some crystallinity. In comparison, nylon 66/610/pip-10 becomes quite crystal-

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line, and at the same time shows the greatest change in physical properties. The conclusion can, therefore, be drawn that the change in properties in all three cases is mostly due to internal physical changes, in other words, crystallization, rather than to chemical breakdown of the amorphous regions.

A second explanation involves the kinetics of polymerization of piperazine relative to the other amide-forming groups present. Piperazine is a secondary amine, and we would expect that this secondary hydrogen atom would be less reactive than the hydrogen atoms of a primary amine. Also, the close proximity of the heterocyclic ring probably introduces some steric factors that also slow down its reaction rate with carboxyl groups. In fact, by direct observation, it takes far longer to prepare a polymer of equivalent molecular weight containing piperazine than it does to prepare one in which none of this diamine is used. Consequently, we might expect that the molecular-weight distribution of these piperazine polymers has a greater spread than that usually encountered, with considerably more short chains. These short chains in turn would have a considerably greater proportion of the less reactive piperazine than would the long chain molecules.

Now, low-molecular-weight polyamides are much more highly susceptible to deterioration of properties during aging, regardless of what additive is used. The inference here is that it takes very little degradation to cause a serious degeneration of properties in polymers of this sort. This point is illustrated by the data in Table VIII, p. 155. This line of reasoning leads to the conclusion that these short chains deteriorate first and then lead to an exaggerated deterioration of the properties of the gross polymer.

At the present time, it is most reasonable to accept the supposition that the deterioration of these piperazine polymers is due primarily to changes in the internal physical make-up of the polymer, i.e., crystallization. This is based partly on information to be published later. The conclusion is, then, that it is unlikely any additive or combination of additives can completely stabilize this polymer against heat aging.

There seems to be no ready-made solution to the problem of stabilizing nylon against deterioration. What is good for one polymer may be completely ineffective in another. The results of this investigation emphasize the specificity of materials in the role they play as stabilizers.

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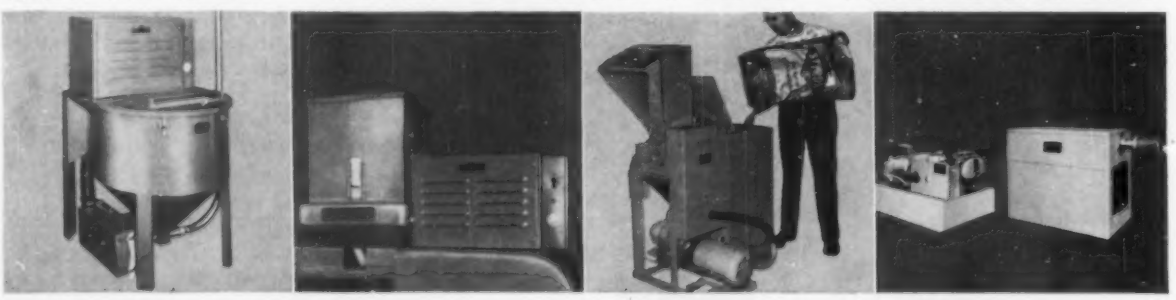

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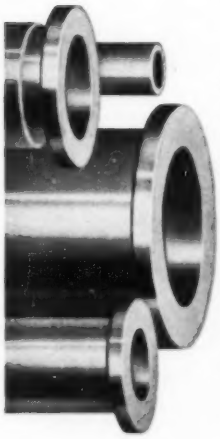

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# THE PLASTISCOPE*

News and interpretations of the news

By R. L. Van Boskirk

**Section 2** *(Section 1 starts on p. 41)*

**July 1960**

### Reynolds forms Plastics Div.

Because of the ever-increasing volume of the company's film products, Reynolds Metals Co. has given full divisional status to its plastics operations.

Woodrow J. Vogel, formerly general market manager for plastics and manager of the company's Grottoes, Va. plastics plant, has been made general manager of the new division. John Alexander, formerly plant superintendent, has been promoted to acting manager of the Grottoes plant and William T. Greene, formerly plant engineer, is now superintendent.

Increasing demand for Reynolon household wrap is probably responsible for creation of the new division. Reynolon, a clinging wrap, is made from cast PVC and is used also for overwrapping products from frankfurters to phonograph records, and for laminations. Reynolds also produces polyvinyl alcohol film, which is water soluble and used for packaging detergents, soaps, bleaches, insecticides, etc., that can be dropped in water and dissolved, plus a medical tape base from a PVC dispersion resin.

### Improved reinforced panels

A lifetime guarantee structurally and a 15-year guarantee for surface, color stability, and light transmitting are the unusual claims made by Filon Plastics Corp., Hawthorne, Calif., for a new fibrous glass-reinforced polyester building panel called Filoplate. A new process is claimed to allow the material to retain its original appearance and physical properties at least three times longer than other translucent fibrous glass reinforced building panels.

The improved material and the unusual guarantees are made possible, according to Filon, by chemically bonding a light-stable, acrylic-modified polyester resin coating to the basic polyester core prior to the curing process, resulting in a resinous surface fully enclosing the reinforced core, say company spokesmen. The old process used by Filon for forming panels was simply a merger of fibrous glass and resin. The new additional bonding process is said to be largely responsible for the stronger bond and accounts for the improved properties.

The new Filoplate, patent pending, is available in 6 and 8 oz./sq. ft. weights, in 16 colors, and in all configurations as well as flat. The new material also includes nylon strands as do all other Filon panels. The nylon is laid in parallel strands, which are claimed to give additional strength to the panel which Filon states are exclusive with that firm and are protected by patent.

### Rigid vinyl sheet 50 in. wide

Homogenous extruded rigid Koroseal normal and high-impact vinyl sheet 50 in. wide and ranging in thickness from 0.060 to 0.125 in., for use in fabricating chemical plant equipment, has been developed by B. F. Goodrich Industrial Products Co., a division of The B. F. Goodrich Co.

Also announced is an extruded rigid Koroseal vinyl sheet primarily designed for use in vacuum forming of refrigerator door liners or similar parts. This sheet is produced in lengths to suit customer requirements, thereby reducing waste, Goodrich claims, because conventional press-laminated sheets are available only in 48 by 96 in. size.

### Water removable marking ink

Temporary marking of plastics products in in-plant operation has long been a problem for the industry. Now a marking ink that can be washed from plastics or other materials with water has been announced by Organic Products Co., Irving, Texas. Named Water Off Ink, it does not etch, withstands abrasion, and is not easily removed by handling of marked pieces, according to the company. The ink is supplied with dyes or pigments, with dyes preferable for non-porous surfaces.

### Vinyl chloride paint

Use of latex or water-based paint for interior surfaces is no longer an experiment. It is here in tremendous volume—is practical and satisfactory—a boon to the do-it-yourself market.

Now B. F. Goodrich Chemical Co. has introduced a vinyl chloride and acrylic copolymer water paint, called Latex 450X3, which it is believed will make outdoor water paint as popular as the indoor types. The new paint can be applied to any surface including previously painted old wood surfaces, and is said to be so versatile that formulations can be used to protect unprimed, oil paint primed, or previously painted wood and masonry surfaces. The acrylic keeps the film flexible throughout the long life expected of paint. The polyvinyl chloride, even at the low pigment volume concentrations necessary for self-priming over wood, provides low tack and long life.

The weathering properties, in contrast to most latex paints, and the ability to use it on old surfaces, are, of course, the particular advantages that make Goodrich believe that this new latex is one of the most important developments in recent paint history.

The rate of moisture vapor transmission of paint films made from Geon 450X3 is claimed to be higher than that of some oil paints, but not as high as most latex vehicles for exterior use. Thus they have a good balance between moisture resist- **(To page 196)**

*Reg. U.S. Pat. Off.

*News about* R&A SINCE 1913 **Adhesives**

**FOR ALL METALS AND ALL PLASTICS**

# New "quick-grab", soft seam adhesives for flexible plastic foams

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- *Set rapidly for swifter mass production*
- *Brush smoothly for lower labor costs*
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While there is no "universal" adhesive for every type of application, our new BONDMASTER® R275 appears to be "the" answer for foam-to-foam bonding.

This new adhesive features as soft and dimple-free a seam as you've ever seen, and a "tearing bond" on all brands of flexible urethane and rubber latex foams.

What's more, current users report these added time-labor-and-cost-saving benefits: "It grabs faster – we can turn over the cushion sooner without it falling apart" . . . "It seems to coat without penetrating – we use less" . . . "It doesn't run off the brushes – cleaner to work with".

Mass-production bonding of urethane foam to carpeting demands a quick-drying, flexible, non-staining, machinable adhesive.

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For foam to fabric, to wood, to metal, to carpeting, to you-name-it, we've a wide range of other "chemical fasteners" developed for specific applications.

BONDMASTER R328T seems to be the favorite for bonding urethane foam to fabric or to wood. BONDMASTER G527 is specified for sound-deadening foams by a leading equipment manufacturer. Our R203 features extremely fast drying solvents for instantaneous bonding of fabric reinforcing tape to foam seats in automotive mass production.

We've a non-staining adhesive for vinyl foams – BONDMASTER R294 – that withstands drycleaning in Stoddard and other naphtha cleaning solvents.

And, of course, the first practical rapid-tack-loss, one-part, fast-grab, soft-seam adhesive for foam rubber – BONDMASTER R225, developed by R&A in 1947 – is still the leading formulation used in that industry.

Tell us about your specific problems so we can send samples of the adhesives most efficient for the materials you are working with.

## *Part of the problem is that they're so versatile . . .*

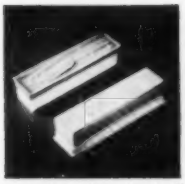
. . . flexible urethane and vinyl foams, we mean.

They're being used in so many different products in so many different ways . . .

And must withstand so many different types of service conditions in end-use . . .

. . . that a "universal" adhesive just "cannot be". (Some bonds must be flexible, others rigid, for example.)

For instance . . .



Urethane foam to itself . . . to foam rubber . . . to wood . . . to rigid styrene . . . to cardboard . . .

You can, however, have one single source of supply if they are equipped to serve you with "families" of adhesives, custom-tailored to each specific type of end-use. As were the BONDMASTER adhesives used in the products shown on this page!

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# THE PLASTISCOPE

(From page 194)

ance and permeability, and are said to keep out rain and snow, yet allow moisture from building interiors to escape. This eliminates blistering and staining caused by moisture which cannot escape.

In white paints where chalk control is important, a Geon 450X3 based paint has resisted wear and grime for three years on a house at the edge of an industrialized area. A window frame painted with this material was whiter after four years than one painted with an oil-base paint after one year.

### Additive for shell molding

A chemical additive reported to increase tensile strength of foundry shell cores and molds as much as 55% has been developed for the foundry industry by Nuodex Products Co., Div. of Heyden Newport Chemical Corp., Elizabeth, N. J. The additive, Nuodex Sand-Plus, is used in the "cold" coating of foundry sands where the resin, usually phenolic, is in solution and mixed with the sand along with a curing agent, hexamethylenetetramine. Nuodex Sand-Plus is added to the resin sand mix and the solvent is evaporated, leaving behind a dry coated sand mixture. Results claimed are: the resin coats more uniformly; the blocking of the coated sand in storage is reduced; maximum power requirements on the mixing equipment are reduced; the hard deposit or "skull" is reduced which increases the usable sand; and removal of the patterns is facilitated.

### New epoxy plasticizer

Drapex 6.8, an epoxidized soybean oil displaying polymeric plasticizer properties, is the newest addition to the line of Mark stabilizers and Drapex plasticizers of the Argus Chemical Corp., New York, N. Y. It is said to provide optimum heat and light stabilizing performance and maximum compatibility in vinyl compounds. Extensive outdoor weathering tests reported by the company have shown that the life of a vinyl compound can be tripled or quadrupled by the addition of Drapex 6.8 to the formulation. Epoxy plasticizers are beneficial in all vinyl formulations, but are especially necessary for compounds containing phosphate or chlorinated paraffin plasticizers. Drapex 6.8 is recognized as non-toxic by the U. S. Food & Drug Administration and, therefore, applicable for food packaging or wherever non-toxicity is a factor, according to the company. Due to its polymeric plasticizing properties Drapex 6.8 is also recommended for formulations requiring resistance to oils, low volatility, and minimum migration. For those vinyl compounds which require low temperature flexibility, a monoester type of epoxy plasticizer such as Drapex 3.2 or Drapex 4.4 should be used instead of Drapex 6.8.

### Source for wood flour

Penn-Rillton Co., New York, N. Y., offers a wood flour that is said to be dust-free. Called Hygeia, the new material is suggested as a filler for plastics molding compositions. The base wood is oak and the material has a bulk density of 17.95 lb./cu. ft. Hygeia wood flour is packed in 50-lb., multiwall paper bags, and costs $39.50 per ton in carload lots.

### Fumaric acid

A new 50-lb. bag for fumaric acid, frequently used in polyester formulations, which will provide a cost saving of ½¢/lb., has been announced by Pittsburgh Chemical Co., a subsidiary of Pittsburgh Coke & Chemical Co. Fumaric acid has in the past been packed in non-returnable fiber drums containing 250 pounds. The new bag will provide fumaric users with a choice of containers for the first time.

Fumaric acid continues to be in short supply, and PCC plans to double its production capacity early in 1961 when its new maleic anhydride plant, currently under construction, comes on stream. The new facility will provide additional raw material for fumaric acid production as well as 20 million lb./year of maleic anhydride. The new price quoted by the Industrial Chemicals Div. of FCC for fumaric acid in bags is 0.2225/lb. TL/CL and 0.2375/lb. LCL, F.O.B. Neville Island, Pa. The corresponding price for drums remains at 0.2275/lb. TL/CL and 0.2425/lb. LCL.

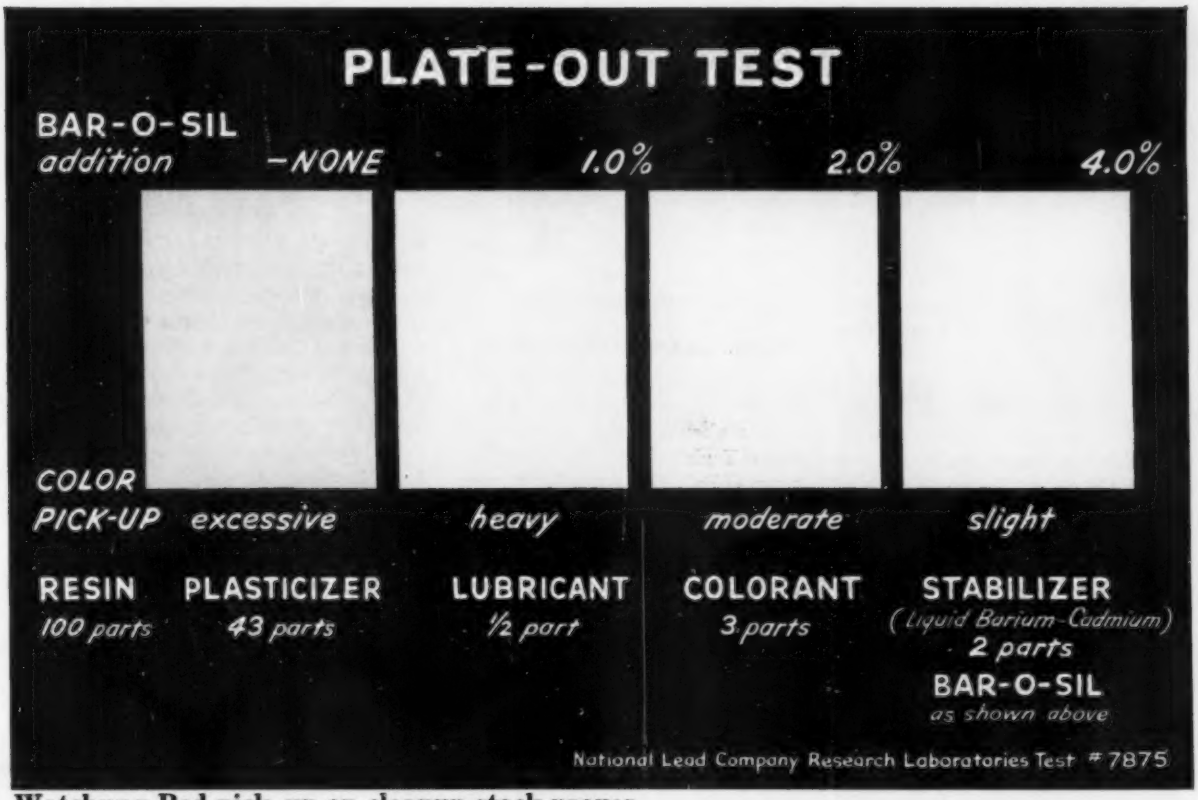
### Teflon accepted by FDA

Use of Du Pont's Teflon TFE-fluorocarbon resins in food handling service has been accepted by the Food & Drug Administration, according to Robert A. Kellar, marketing manager for Teflon in the Du Pont Polychemicals Dept. The FDA ruling paves the way for dozens of new applications for Teflon, many of which are already well along in their development stages. An important area into which use of the resins is expected to expand is food processing. One member of the resin family, Teflon 6 TFE resin, had already been accepted by FDA (Aug. 1959) for use in milk handling equipment. The latest action of the federal agency gives virtual across-the-board clearance to Teflon TFE resins.

Teflon resins are used in the extrusion of tubing, overbraided hose and pipe linings, and to impregnate fibers and fabrics for such items as conveyor belts used in candy manufacturing processes, and in non-stick coatings and films of the type used in both baking and candy-making processes. They are also used to produce gaskets, seals, packings, and non-lubricated bearings or other molded items such as filler nozzles which can be used on food-processing machinery as well as in sheet, rods, and billets from which components may be machined or tape skived. The ruling covers only forms fabricated from the virgin Du Pont Teflon resins.

### Porous PVC retains liquid

A microporous PVC material that holds liquid in its pores and will release that liquid at a desired rate is now being investigated for a variety of uses by S. C. Johnson & Son Inc., Racine, Wis. Called Porelon, its first commercial use is a handstamp that can make more than 30,000 impressions without re-inking. Other **(To page 198)**




**Watchung Red pick-up on cleanup stock proves...**

# novel new supplementary stabilizer gives best-yet control of plate-out

### No need to change barium-cadmium stabilization base!

There is a standard vinyl industry test of plate-out. Recently, at National Lead Laboratories, we used it to evaluate a new and novel approach to the control of plate-out . . . with gratifying results.

Test procedure was simple. BAR-O-SIL*, a newly developed National Lead barium-silicate supplementary stabilizer, was added in varying quantities to a number of different barium-cadmium-stabilized stocks heavily overloaded with Watchung Red. Immediately after calendering each sample, a cleanup compound was run. Degree of color pick-up indicates degree of plate-out control established by given levels of BAR-O-SIL stabilizer content. In our many tests, the reduction of color pick-up has always been proportional, depending on extent of plating initially present.

### Stop one production run, start the next... in minutes without cleanup

As you can see, BAR-O-SIL stabilizer provides an interesting new tool for plate-out control in barium-cadmium-stabilized stocks. Now it's practical to run color after color in quick succession.

Best of all, this unique supplementary stabilizer provides plate-out control without affecting proven (or new) stabilizations, without altering sensitive colorants, and without increasing yellowing or susceptibility to staining.

BAR-O-SIL stabilizer has several additional desirable effects . . . adds heat stability; sharply reduces hazing, crocking, spewing; controls migration of plasticizer. In calendered products, it imparts a very pleasing dry hand.

### Brochure for the asking

Would you like the technical details? Use the coupon below to send for the BAR-O-SIL brochure. *Trademark

KL-6290

National Lead Company: *General Offices;* 111 Broadway, New York 6, N. Y.
*In Canada:* Canadian Titanium Pigments Limited, 1401 McGill College Avenue, Montreal
Gentlemen: Please mail me your BAR-O-SIL stabilizer brochure.

Name_____ Title_____

Firm_____

City_____ State_____

**BAR-O-SIL***
*(Stabilizer)*

*A Chemical Development of* **National Lead Company**
*General Offices:* 111 Broadway, New York 6, N. Y.

# THE PLASTISCOPE

*(From page 196)*

uses are applicators for hair dyes, lotions, and lubricating uses in industrial equipment. The new material is based on a PVC plastisol that can be molded to almost any shape and can be formulated to contain almost any liquid. The release rate of the contained liquid may be controlled as required by varying the viscosity, the company claims. Also, the hardness of Porelon can range from spongy to rigid (20 to 100 Shore A).

### Crosslinking agent

Propylene imine is being manufactured and offered in commercial quantities by Interchemical Corp., New York, N. Y. This highly versatile compound contains the very reactive three-membered imine ring. This ring opens at the carbon-nitrogen bond to yield addition products when reacted with hydrogen compounds and polymers when reacted with other imine molecules. It will also undergo all the reactions of secondary amines, the company states. Because of its versatility propylene imine will be of interest as a crosslinking agent for polymers, in paper and textile treatments, in rubber processing, and in many other applications.

Its derivative Mapo, tris (1-(2-methyl) aziridinyl) phosphine oxide, is also available from Interchemical and has proven to be a successful crosslinker of interest in many fields.

### Penton price reduction

Penton, Hercules' chlorinated polyether molding compound, is now $2.50/lb., compared with a previous price of $3.50. Olive drab and black are now $2.60. Even greater price reductions have been effected in other than large volume quantities. The company also announced availability of Penton in a new form—finely divided powders which are suitable for use in organic dispersions and other coating systems.

The reduced price, plus availability of a coating material is expected to increase the market in such applications as pipe and fittings, valves, tank linings, vessels, pump and meter parts, and in combination with low-cost metal substrates where it is particularly applicable to serve in corrosive, high-temperature exposures.

### Creped paper base laminate

A post-forming laminate, consisting of a creped paper base bonded with a phenolic resin is available from Taylor Fibre Co., Norristown, Pa. Designated Grade XX-7, the new material can be readily formed and drawn, and suggested applications include fan blades, formed panels, bulkheads, ribs, and side panels, battery box containers, etc. The laminate is supplied in sheets of 49 by 49 in., in thicknesses from 1/32 to 1/4 in., in black or natural. The 1/32-in. thickness can be hot punched, the company states.

## New Companies

**Southwest Chemical & Plastics Co.,** a newly formed company, has announced plans to build a plant near Houston, Texas. Facilities with a capacity of approximately 10 million lb. per year are being constructed for custom production of blends and dispersions of carbon black and other pigments in polyethylene, polypropylene, and other plastic materials. The company will supply formulations to the Gulf Coast plastics resin manufacturing industry. Laboratory and research facilities will be included to provide experimental blends as required by plastics resin manufacturers. Completion of the plant is expected in September 1960.

Officers of the new company are **T. B. Hudson,** president, and **Ken W. Minix,** vice-president. Pending completion of plant construction, offices of the new company will be temporarily located at 1534 Tennessee Bldg., Houston.

**Dynatech Plastics Inc.,** Santa Ana, Calif., was established by **Martin Usab,** formerly director of research, Rexall Drug & Chemical Co., for the manufacture of injection moldings utilizing materials normally considered difficult to mold. Mr. Usab, who introduced the Ankerwerk system of molding to the United States in the Rexall operation, will use the same concept in his new facility.

**Olympic Chemical Co.,** Greensboro, N. C., is a newly organized company for the production of polyurethane foam for the furniture, textile, and rug industries. **Cone Mills Corp.,** Greensboro, has a major interest in the new firm. **Robert W. Ward,** formerly production manager of Nopco Plastics Div., has been named president, **Sydney M. Cone Jr.,** vice-president, and **Lester W. Bates,** previously research supervisor for Hewitt-Robins Inc., appointed plant manager. Between 25 and 30 people will be employed at the start of operations in July.

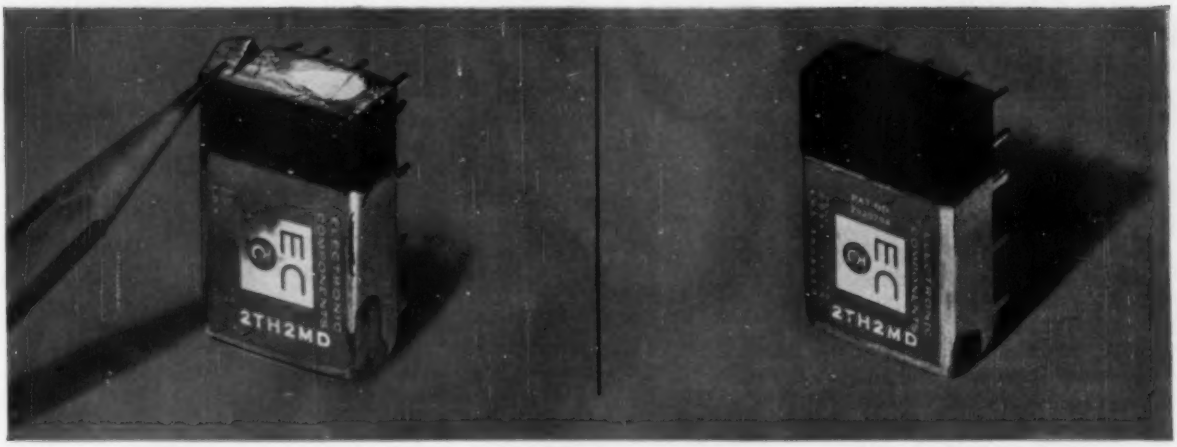
**National Laminating Sales Co.,** 1263 Westwood Blvd., Los Angeles, Calif., was formed for the sale and distribution of the Lok-in Label for all types of plastic and glass containers. This label utilizes a cold-seal process which makes possible the application of a permanent, full-color label to squeeze, semi-rigid, and rigid plastic bottles by manual or high-speed automatic equipment. The company claims it provides advantages not available with silk screen and hot stamping.

**The Hull Development Co.,** Ann Arbor, Mich., a new consultant firm specializing in development, production, and sale of plastic and rubber industrial and consumer products, has been formed by **James W. Hull,** former vice-president and general manager of Reynolds Chemical Products Co. The company plans are to have a laboratory in Ann Arbor staffed with engineers and technicians, authorities in their specialties.

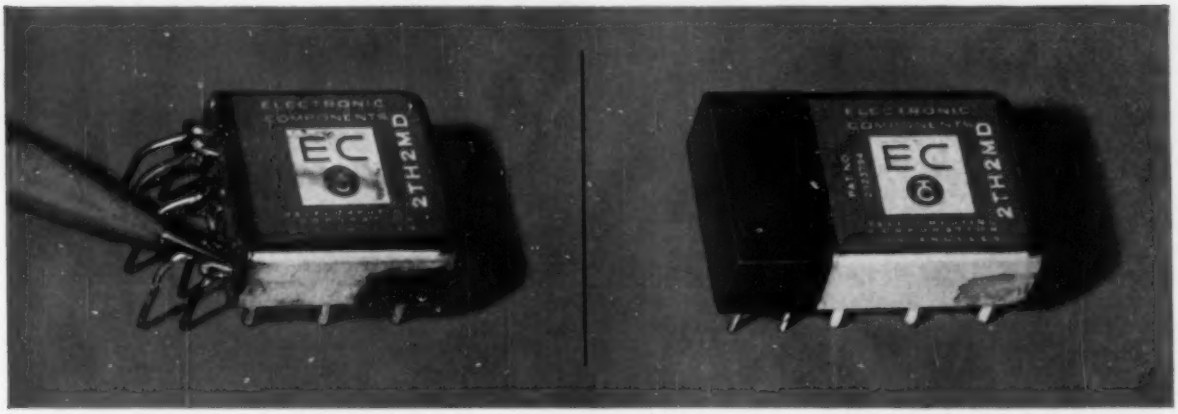
## Expansion

**The Flintkote Co.,** a leading manufacturer of building products, has acquired all outstanding stock of **The Sealzit Co.,** Riverside, Calif., for more than $1 million in cash. The Sealzit Co. manufactures **(To page 200)**

DOW | THERMOSETTING RESINS




Under 180°C. heat, the ordinary epoxy resin cracked . . . but the epoxy novolac potting was unharmed!




In an epoxy stripper, the epoxy resin potting dissolved . . . but the epoxy novolac showed no significant change after two weeks' immersion!

# DOW EPOXY NOVOLAC UNHARMED

## by brutal heat and chemical torture tests!

Tests conducted by an electronics component manufacturer prove it! Compared on the basis of their ability to withstand extreme heat and powerful chemical attack, these two miniature relays demonstrated the amazing difference between a regular high-quality epoxy resin, and Dow epoxy novolac resin (D.E.N. 438).

The test to determine the effects of prolonged intense heat on these two terminal pottings took place in a 180°C. oven. After five hours, the ordinary epoxy resin potting compound cracked. But after 100 hours of continuous 180°C. heat, the Dow epoxy novolac was unharmed!

A chemical resistance test compared the ability of each potting compound to withstand the action of high-powered stripping solvents similar to solvents used in cleaning electronics equipment. The ordinary epoxy resin formulation was completely dissolved after only 48 hours in the stripper. But the Dow epoxy novolac potting showed no significant change, even after two weeks' immersion!

These results prove once again that in potting, molding, encapsulating and laminating, or in any application where performance is critical, Dow epoxy novolac resins can provide the extra measure of physical and chemical stability necessary for success.

New applications for the complete Dow family of thermosetting polymers are being uncovered every day. If you have a problem that could benefit from their hardness, toughness, dimensional stability, and chemical resistance, call your nearest Dow sales office. Or write: THE DOW CHEMICAL COMPANY, Midland, Michigan, Plastics Merchandising Department 1965CS7.

**THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN**

# THE PLASTISCOPE

*(From page 198)*

Sealzit Guns and accessory equipment used in the application of resins, binders, and plastics to make such products as boats, trailers, and furniture. **Dominic Shelton, V,** former president of Sealzit is being retained by the company as a consultant.

**Allied Chemical Corp.** plans to acquire the assets and business of **Specialty Resins Co.,** Lynwood, Calif. In making the announcement, **Frank M. Norton,** executive vice-president of Allied's **Plastics & Coal Chemicals Div.,** stated that acquisition of Specialty would provide the division with its initial production facility in the West Coast for resins and plasticizers. Included in Allied Chemical's West Coast expansion plans is a plant to be used for production of phthalic anhydride.

Allied Chemical's **National Aniline Div.** plans to more than triple the production of isocyanates with a multi-million dollar investment in new construction and equipment at its Moundsville, W. Va. plant. Construction is expected to be completed by 1961.

**Plastic Molders Supply Co.** with offices and plants in Fanwood, N. J.; Norwalk, Ohio; Worcester, Mass.; and Chicago, Ill. has announced the opening of a new plant and office in Fort Worth, Texas. The new facility will produce and sell a new color coat (gel coat) for the reinforced plastics industry, and will also produce color paste dispersions for polyesters and epoxies, as well as colorants for thermoplastics.

**Ludlow Corp.,** Needham Heights, Mass., is planning a $750,000 expansion at its **Plastics Div.** plant in Homer, La. This division produces cast polyethylene, nylon, and polypropylene films and coated materials. Other divisions are **Textile Products, Ludlow Papers,** and **Orcco Industries,** which produces rug cushions. The Textile Products Div., already a big producer of jute fabric in India, will soon build another jute plant in Jamaica, W. I. The company's five-year budget planning is based on a projected minimum growth of 20% annually. **President Austin B. Mason** forecast a 1960 earnings of $4.00 per share.

**Molded Fiber Glass Tray Co.,** Linesville, Pa. manufacturer of Toteline products, has purchased the former **Fiberglass Box Co.** of Ashtabula, Ohio. The acquisition includes all manufacturing and design rights for Fiberglass Box Co.'s line of fabricated fibrous glass reinforced plastics, vulcanized fibre, and aluminum-walled tote boxes. These same products will be manufactured under the Toteline label.

**Swedlow Inc.,** Los Angeles, Calif., has installed two specially designed 400-ton presses for the molding of large reinforced plastics parts. The new presses are rated at 2500 p.s.i., with 36 by 36 in. steam-heated platens. Maximum pressure of full platen area is 605 p.s.i. One of the presses has a 60-in. stroke with 72-in. daylight; the other has adjustable daylight to 120 inches.

Basic design of 2000- and 3000-ton presses for future installation has been completed by Swedlow. Specifications for the 3000-ton unit calls for 8 by 8 ft. platens, with 20 ft. daylight. They will be placed in operation in late 1960 or early 1961.

**Peerless Plastics Co.,** Culver City, Calif., has completed a $250,000 expansion program started last year, with the activation of the Blow-Molding Div., **Arthur P. Sugarman,** president of the firm, announced. The new division will be housed in the present plant, and will be headed by **Walter Hubinger,** manager; **William Rountree,** plant superintendent; and **Robert Walker,** research and technical director. The division is equipped to custom mold items from 1 oz. to 5 gal. in capacity.

Three completely automatic machines are already going at full capacity, producing bottles, toys, and houseware items. Also in operation is a complete silk screening department. The company will mold a variety of items from low- and high-density polyethylene, polypropylene, high-impact styrene, acetate, nylon and other materials.

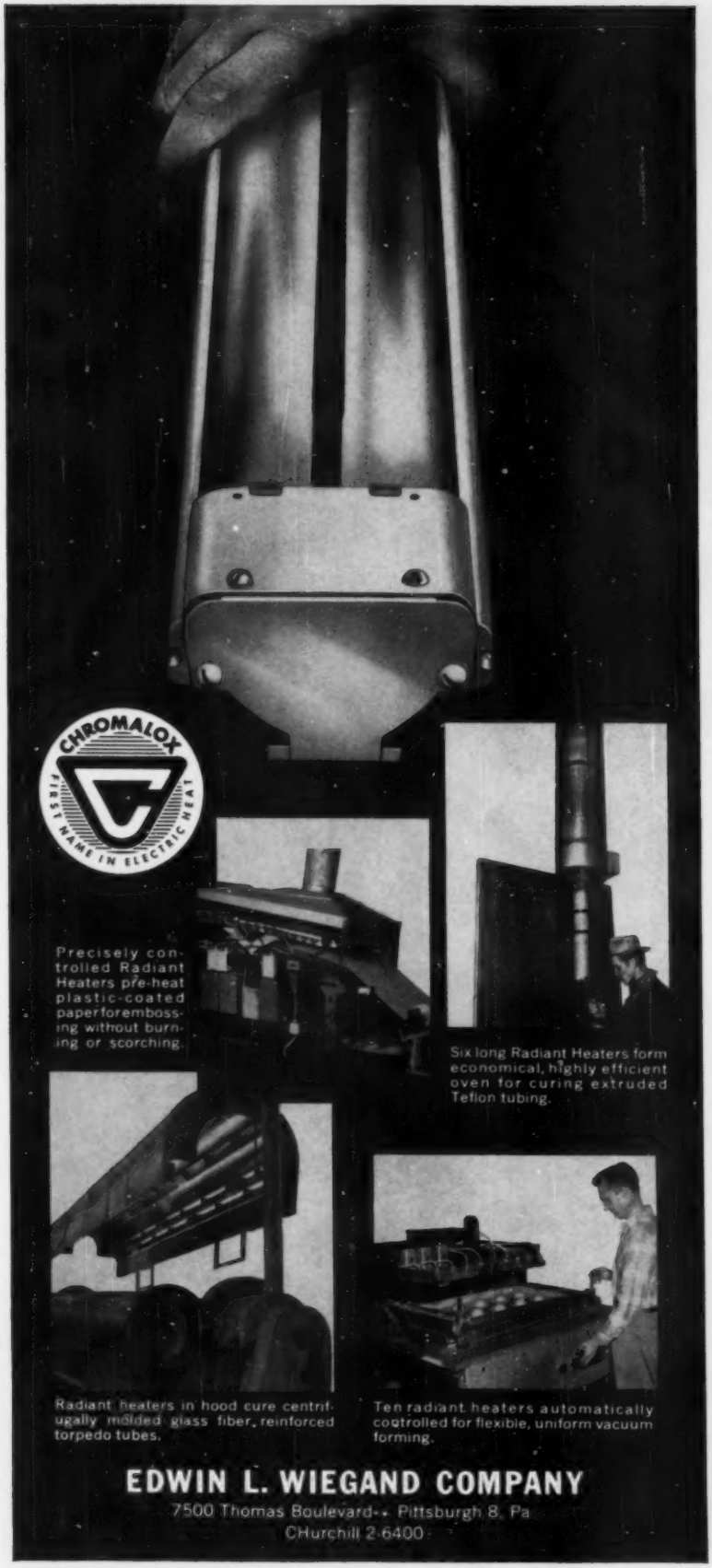
**Archer-Daniels-Midland Co.** has announced that it will build a multi-million-dollar chemical center on a 200-acre site near Peoria, Ill. The ADM center will be a grouping of several chemical processing facilities. When in full production, it will employ about 200 workers and will have facilities for increased production of nitrogen chemicals, plasticizers, esters, olefins, as well as other chemical intermediates.

**Colton Chemical Co.,** a division of **Air Reduction Co. Inc.,** plans to construct a new resin plant at City of Industry, Los Angeles County, Calif., on a five-acre tract purchased recently. Facilities will include a sales office, technical service laboratory, and a warehouse. The plant will be devoted to resin polymerization and will produce copolymer emulsions and polyvinyl acetate resins used in the formulation of paints, adhesives, and paper coatings.

**Monsanto Chemical Co.,** St. Louis, Mo. and the **Societe Industrielle de la Cellulose (SIDAC), S.A.,** of Belgium announced formation of a new company with headquarters in Brussels, Belgium. The new company will build a plant in Ghent, Belgium to manufacture Monsanto's Saflex polyvinyl butyral plastic sheets. The plant is expected to be in operation in 1961.

**Monsanto Chemical Co., Plastics Div.,** Springfield, Mass., has established an engineering center to develop new and improved machinery and methods for manufacturing and converting plastics, as well as specially engineered plastics products.

**Duranor, Industrial Quimicas S.A.,** has received a loan from the Export-Import Bank, Washington, D. C., which will be used for the purchase in the United States of chemical equipment for a new phenol plant to be **(To page 204)**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Precisely controlled Radiant Heaters pre-heat plastic-coated paperforembossing without burning or scorching.
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# CHROMALOX

## ELECTRIC RADIANT HEATERS

### fast, uniform, economical, safe

Here's high-intensity heat . . . adjustable from 0 to 100% of heating capacity by fingertip control. Different zones of heat intensity can also be set up . . . by arranging heaters in different "banks" with individual controls for each.

Chromalox Far-Infrared (long wave length) is absorbed almost equally fast by all colors, textures and surfaces . . . including clear glass, plastics, cellophane.

*For heating, baking, drying, curing, pre-heating, dehydrating, pre-expanding.*

Space-saving, non-breakable, all-metal units withstand knocks, bumps, vibration. Moisture-resistant terminals available. No fumes, flames, glare or leaky pipes. Standard heating lengths to 150 inches. Immediate delivery from stock. Low-cost installation and operation. You can build production line heating tunnels, ovens, banks right on the job.

Write for Bulletin G62. Or, for fast action and on-the-job assistance with your heating problem, call your Chromalox Man listed below. 91874

**Call Your Chromalox Man for Heating Answers**

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Hobart 3-0626

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BALA-CYNWYD, PA.
Mohawk 4-6113
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BALTIMORE, MD.
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Edison 8-6900
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BOSTON, MASS.
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Amherst 7-8260

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DAVENPORT, IOWA
Phone: 6-5233

DENVER, COLO.
Glendale 5-3651
Genesee 3-0821

DES MOINES, IOWA
Cherry 3-1203

DETROIT, MICH.
(See Southfield, Mich.)

HOUSTON, TEX.
Capitol 5-0356

INDIANAPOLIS, IND.
Melrose 5-5313

KANSAS CITY, MO.
Victor 2-3306

LOS ANGELES, CAL.
Richmond 7-5191

MIDDLETOWN, CONN.
Diamond 6-9606

MILWAUKEE, WIS.
Broadway 1-3021

MINNEAPOLIS, MINN.
Federal 6-6631

NASHVILLE, TENN.
Cypress 2-7016

NEW YORK CITY, N.Y.
(See Bloomfield, N.J.)

OMAHA, NEB.
Atlantic 7600

PHILADELPHIA, PA.
(See Bala-Cynwyd, Pa.)

PITTSBURGH, PA.
Emerson 1-2900

PORTLAND, ORE.
Capitol 3-4197

RICHMOND, VA.
Atlantic 8-8758

ROCHESTER, N.Y.
Hamilton 6-2070

ST. LOUIS, MO.
Chestnut 1-2433

SAN FRANCISCO, CALIF.
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SEATTLE, WASH.
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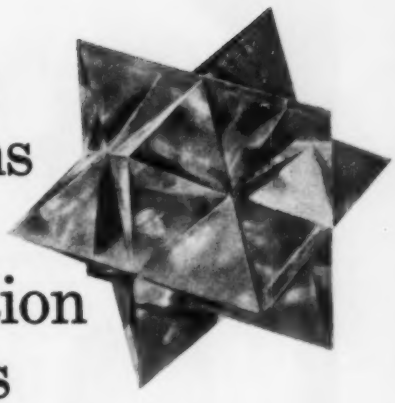
SOUTHFIELD, MICH.
Kenwood 8-2100
Elgin 7-0677

SYRACUSE, N.Y.
Granite 4-3933

WICHITA, KAN.
Amherst 2-5647

# Prompt solutions to your production puzzlers



**MONSANTO TECHNICAL SERVICE** recently .... recommended the one cement among hundreds that solved a molder's sealing problem and cleared the way for the production of a unique plastics cream-dispensing container .... employed a revolutionary system (developed by Monsanto) for measuring styrene colors, duplicating a customer's color sample with an accuracy never before attainable .... custom-formulated a new material to deliver the desired combination of properties required in a manufacturer's newly designed end product.

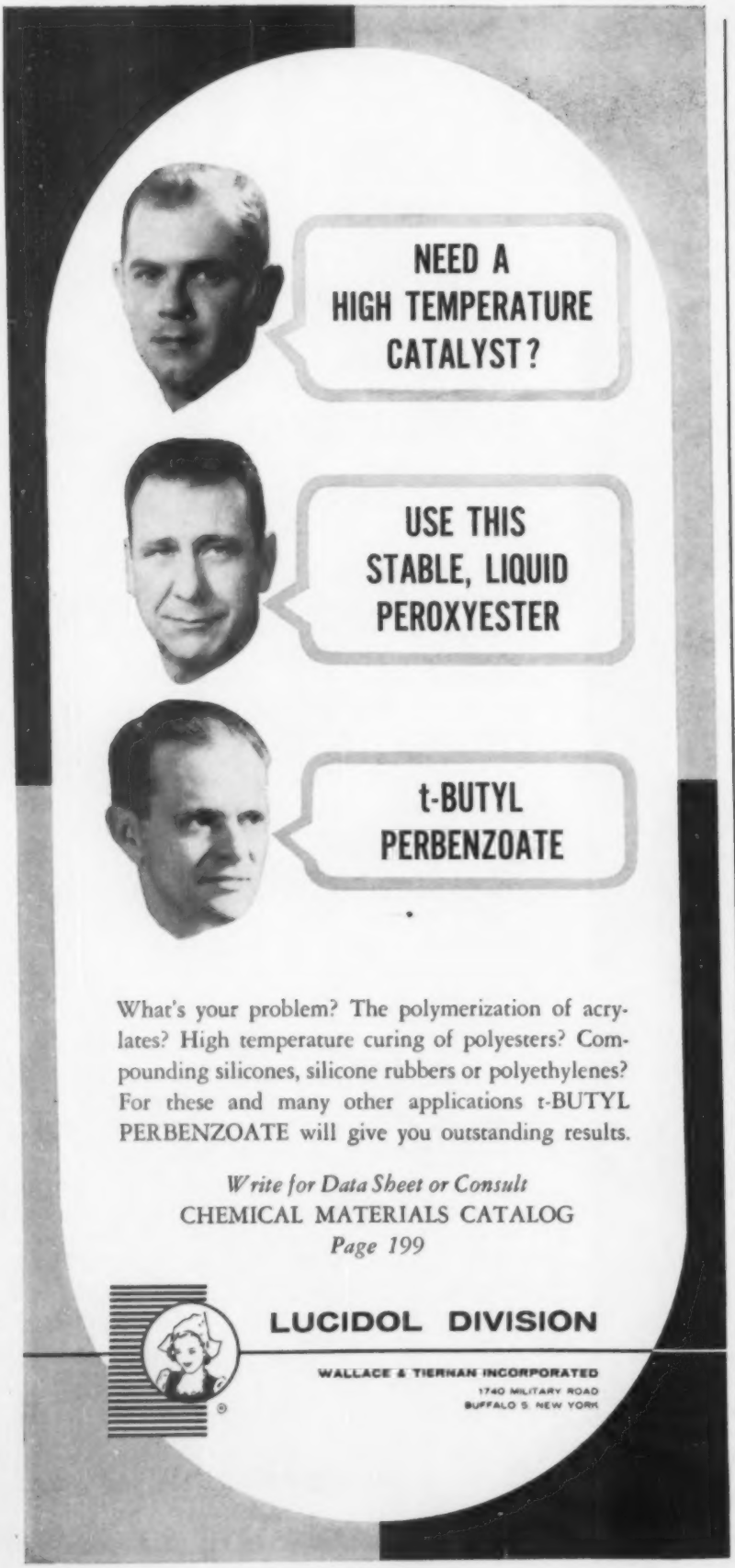
These are typical of the many different jobs this department does regularly to help promote customer success. There are Monsanto Technical Service field men on constant call to unravel knotty plastics production line problems on the spot—and keep manufacturers fully informed about new materials, processes, and testing methods. The Customer Service Laboratories draw on a wealth of experience and accumulated data to evaluate specific needs. Objective material recommendations can be made because of the wide range of Monsanto products and formulations.

Molders, extruders, designers, converters, laminators, processors, manufacturers all profit today from Monsanto technical guidance in producing better looking, better operating, better selling plastic products. Monsanto Chemical Company, Plastics Division, Springfield 2, Mass.

**MONSANTO** ACTIVATOR IN **PLASTICS**

Monsanto

FREE: If you would like this plastic puzzle, just ask your Monsanto Representative.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CATALYST?
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STABLE, LIQUID
PEROXYESTER
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What's your problem? The polymerization of acrylates? High temperature curing of polyesters? Compounding silicones, silicone rubbers or polyethylenes? For these and many other applications t-BUTYL PERBENZOATE will give you outstanding results.
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BUFFALO 5, NEW YORK

## THE PLASTISCOPE

*(From page 200)*

built in Argentina. Duranor was recently formed by **Atanor, Compania Nacional para la Industria Quimica,** Buenos Aires, Argentina, and **Hooker Chemical Corp.,** Niagara Falls, N. Y. Capacity of the new plant will be 25 metric tons per day, and **Plasticos Atanor,** an Atanor subsidiary, will be the largest customer of phenol for the manufacture of phenolic resins and molding compounds.

**Mechanics Inc.,** a leading distributor of Formica and Formica Flakeboard, has opened new offices and warehouse encompassing a total area of 36,000 sq. ft., at 55-11 Queens Blvd., Woodside, Long Island, N. Y. Also located in the new building will be **Melco,** a new division created by Mechanics Inc., to make carbide cutters for plastic laminates.

**Valchem,** a unit of **United Merchants & Manufacturers Inc.,** Langley, S. C., has broken ground for a $250,000 expansion that will include two new stainless steel reactors in which the company will make a series of specialty resins including polyesters, and industrial intermediates for paper and textile coatings, etc., which have not previously been marketed by the company.

**Stolper Steel Products Corp.,** Menomonee Falls, Wis., has expanded into the field of reinforced plastics with the purchase of **Plasticon, Inc.,** El Monte, Calif. The new subsidiary will continue operations under its present management. At the same time, Stolper is planning establishment of a second reinforced plastics operation at its main plant. Stolper is a producer of sheet metal parts and sub-assemblies to customer specifications in the automotive, agricultural, and industrial fields. Plasticon manufactures fibrous glass reinforced plastics parts for the aviation, automotive, marine, and chemical industries. It specializes in high- and low-temperature reinforced laminates for the missile and military and commercial airframe industries. Current projects include an- **(To page 206)**

DOW Plastiatrics

DOW'S CLINICAL APPROACH TO HEALTHY PLASTICS APPLICATION

# CALCULATING CREEP AND STRESS RELAXATION FROM LONG-TERM DATA

For design engineers concerned with calculating the effects of stress and strain on plastics materials, particularly in designing for long-term applications, the Equations of State (Fig. 1) permit good approximations, to which, of course, will be added a reasonable safety factor.

Obviously, long-term strength data must be used in the equations, since short-term or elastic data do not correlate with long-term service. For example, in designing plastic lawnmower wheels, data obtained over a five-year period would normally be used because this period of time corresponds to a reasonable service life for this type of part. Below are examples of calculating stress, strain and the modulus of elasticity, using long-term data from Fig. 2. These are simple situations. Often shock, high temperatures or other environmental factors must also be taken into consideration.

**Example I:** A tensile stress of 1000 psi will be applied to a part made of Tyril 767. How much creep will occur during the first six months (4320 hours)? From Fig. 2, the Apparent Modulus at six months is 420,000 psi. Using Equation 2a (Tension):

$$E=\frac{S}{\epsilon} \text{ and } \epsilon=\frac{S}{E}. \text{ Then } \epsilon=\frac{1,000}{420,000}=0.0024, \text{ or } 0.24\% \text{ elongation.}$$

**Example II:** Where a known strain is placed on a part, such as a bottle closure, calculate the remaining stress (resistance) after one year. Assume the strain to be 0.42%. Apparent Modulus of Tyril 767 after one year is 380,000 psi.

$$S=E\,\epsilon=(380,000)\,(0.0042)=1590 \text{ psi remaining.}$$

**Example III:** Creep is important in designing webbing and cloth from plastic monofilament. From Fig. 2, Apparent Modulus of Dow saran monofilament after 1½ years is 70,500 psi. Under a stress of 1000 psi, creep is then:

$$\epsilon=\frac{S}{E}=\frac{1000}{70,500}=0.0142 \text{ in./inch, or } 1.42\% \text{ elongation.}$$

**Example IV:** In a hypothetical filter sump for a home water system, the filter must last five years, and operate at a maximum internal pressure of 75 psi. To insure a sufficient O-ring seal, total radial deformation of the sump must be less than 0.007 in., to prevent leakage. Tyril 767 has good long-term strength, ease of fabrication and low cost. Will it be satisfactory for this use? The design strength of Tyril 767 is 980 psi (from Fig. 2) over a period of five years (43,800 hours). From the following formula, solve for "P" (maximum allowable operating pressure).

$$P=\frac{S\left[r^2(b^2-a^2)\right]}{a^2(b^2+r^2)}=120 \text{ psi.}$$

Where: a=inner radius=2.05 in.
b=Outer radius=2.30 in.
r=Normal radius=2.175 in.
v=Poisson's Ratio=0.035
Δa=Change of inner radius, in.
S=(design) Hoop Stress, psi
P=(maximum allowable operating) Pressure, psi.

Thus, the maximum allowable operating pressure for Tyril 767 is well above the operational maximum encountered in the water system. To determine total radial change of the O-ring:

$$\Delta a=P\,\frac{a}{E}\left[\frac{b^2+a^2}{b^2-a^2}-v\left(\frac{a^2}{b^2-a^2}\right)-1\right]=0.00225 \text{ inch.}$$

Not only is the five-year design strength of Tyril 767 adequate for this application, but it provides a safety factor of 1.6 for operating pressure, and of 3 for the O-ring seal.

Many long-term data of the type used in the examples above, are being developed by Dow Plastics Technical Service Engineers for use by plastics engineers and designers. Such continuing Plastiatrics studies provide not only properties data, but also information on improved methods of design, molding and finishing of plastics. For more detailed information on these studies, write THE DOW CHEMICAL COMPANY, Midland, Michigan, Plastics Sales Dept. 1801CS7.

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**EQUATIONS OF STATE**

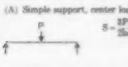
1. To calculate simple stresses

(a) Stress in Tension: or in Compression

$S=\frac{P}{A}$ P = Applied load; A = Cross-sectional area of the part

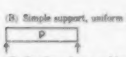
(b) Stress in Flexure (rectangular beam)

(A) Simple support, center loading



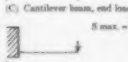
$S=\frac{3PL}{2bd^2}$ P = Applied load; L = Distance between supports; b = Width of beam; d = Depth of beam

(B) Simple support, uniform loading



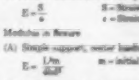
$S=\frac{3PL}{4bd^2}$

(C) Cantilever beam, end loading



$S\,max.=\frac{6PL}{bd^2}$ P = Applied load; L = Distance from load to support; b = Width of beam; d = Depth of beam

(D) Cantilever beam, uniform loading



$S\,max.=\frac{3PL}{bd^2}$

2. To calculate modulus of elasticity in the above examples.

(a) Modulus in Tension; or in Compression

$E=\frac{S}{\epsilon}$ S = Stress; ε = Strain

(b) Modulus in flexure

(A) Simple support, center loading

$E=\frac{Lm}{4bd^3}$ m = initial slope of flexure curve

(B) Simple support, uniform loading

$E=\frac{5La_m}{32bd^3}$

(C) Cantilever beam, end loading

$E=\frac{4La_m}{bd^3}$

(D) Cantilever beam, uniform loading

$E=\frac{5La_m}{2bd^3}$

FIG. 1

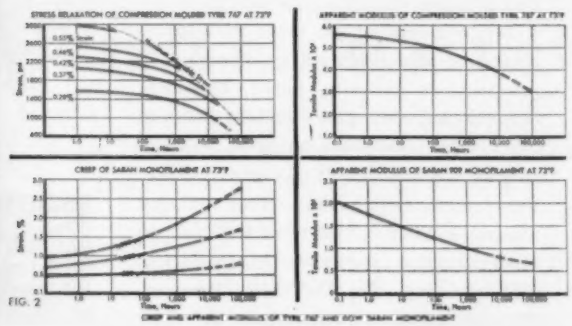

STRESS RELAXATION OF COMPRESSION MOLDED TYRIL 767 AT 73°F
APPARENT MODULUS OF COMPRESSION MOLDED TYRIL 767 AT 73°F
CREEP OF SARAN MONOFILAMENT AT 73°F
APPARENT MODULUS OF SARAN 909 MONOFILAMENT AT 73°F
Time, Hours

FIG. 2

CREEP AND APPARENT MODULUS OF TYRIL 767 AND DOW SARAN MONOFILAMENT

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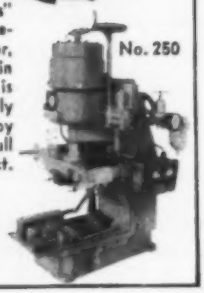

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## THE PLASTISCOPE

*(From page 204)*

tenna guards for the Atlas missile, missile nose cones, and window frames for commercial jet airliners. The plant includes equipment for matched-metal mold work, as well as for hand lay-up, spray-up, and vacuum bag molding.

**D. D. Wensink,** president and general manager of Stolper and its affiliate, **Allen Industrial Products Inc.,** will become chairman of the board for Plasticon. **Walter Podolak** will retain the position of president. **Lloyd A. Gerlach** was named sales mgr.

**Acme Resin Corp.,** Forest Park and Chicago, Ill., has completed an addition to its Chicago plant for producing diallyl phthalate molding compounds, which increases manufacturing space some 40 percent. The added space will be used to produce new automatic molding compounds with improved fire-resistant characteristics. This construction completes a one-year expansion program which has doubled the company's manufacturing capacity.

**Bel-Art Products,** Pequannock, N. J., has completed a new addition to its plant which has tripled manufacturing facilities. Bel-Art specializes in plastic medical and laboratory ware.

**National Geophysical Co. Inc.** has acquired **Electro Plastics Corp.,** Dallas, Texas, which will be operated as a division of National, headed by **Joe Baxt** who will continue as president of the plastics firm, producer of products for the electronic, architectural, packaging, and oil industries. Electro also produces plastics shapes, sheet materials, light diffusers, and electronic sealing products.

**Owens-Illinois Glass Co.** announced plans to open new plants in Chicago, Ill. and Cincinnati, Ohio, for the manufacture of semirigid plastic bottles for packaging liquid detergents and other household products. The Chicago plant is expected to begin production by Aug. 1, and the plant at Cincinnati should be in operation

by mid-September. The new facilities will bring to five the number of new plastic container plants Owens-Illinois has opened since it introduced the high-density polyethylene bottle two years ago.

**John Dusenbery Co. Inc.,** manufacturer of slitters and rewinders, moved its plant and offices from Verona to 380 Allwood Rd., Clifton, N. J. With more than double the floor space, additional machinery has been installed.

**Crescent Plastics Inc.,** Evansville, Ind., has completed an addition to its plant consisting of approximately 44,000 sq. ft., which will be used for additional extrusion capacity and warehouse space. Crescent manufactures a line of plastic pipe and also does custom extrusion work.

## Meetings

### Plastics groups

**Sept. 8, 9:** Society of Plastics Engineers Inc. (S.P.E.), Eastern New England Section, "New horizons in vinyl and plastics in the shoe industry," Statler-Hilton Hotel, Boston, Mass.

**Sept. 22:** S.P.E. Binghamton Section, "Plastics in business machines," Sheraton Inn, Binghamton, N. Y.

**Oct. 5:** S.P.E., Golden Gate Section, "Plastics versus corrosion," Mark Hopkins Hotel, San Francisco, Calif.

**Oct. 13, 14:** The Society of the Plastics Industry Inc. (S.P.I.), 16th Annual New England Section Conference, Wentworth-by-the-Sea, Portsmouth, N. H.

**Oct. 17-19:** International Congress 1960 on the Technology of Plastics Processing, Koninklijk Instituut voor de Tropen, Mauritskade 63, Amsterdam, Holland.

**Oct. 19-26:** International Plastics Exhibition, "macroPlastic 1960," Croeselaan exhibition grounds, Utrecht, Holland.

**Nov. 30-Dec. 2:** British Plastics Federation, 2nd International Reinforced Plastics Conference, Cafe Royal, London, England.

**June 5-9, 1961:** S.P.I. 9th National Plastics Exposition and National Plastics Conference, Coliseum and Commodore Hotel, New York, N. Y.

### Other groups

**July 11-15:** National Housewares Manufacturers Assn., 33rd National Housewares Exhibit, Convention Hall, Atlantic City, N. J.

**July 19-21:** 1960 Western Packaging & Materials Handling Exposition, Pan Pacific Auditorium, Los Angeles, Calif.

**Sept. 11-16:** American Chemical Society, 138th National Meeting, and "Chemical Exposition U.S.A. 1960," Sept. 13-15, Statler Hilton Hotel, New York, N. Y.

**Oct. 9-11:** American Society of Mechanical Engineers, in cooperation with the National Rubber & Plastics Professional Div. of A.S.M.E., Rubber and Plastics Conference at the Hotel Lawrence, Erie, Pa.—**End**


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# COMPANIES...PEOPLE

Appointments, promotions, and relocations in the plastics industry.

**Union Carbide Plastics Co., Div. of Union Carbide Corp.: H. A. Dinwiddie** appointed a special rep. at the Larchmont, N. Y., office. He has been a tech. rep. in the metropolitan New York region for Bakelite plastics for flexible packaging since 1958.

**Robert C. Schroeder** appointed mgr.—film and sheeting, responsible for marketing of all flexible calendered vinyl film and sheeting products. He will be located in the New York, N. Y. office.

**Charles A. Wales**, formerly asst. plant mgr. in charge of vinyl and polyethylene resin operations at the Texas City, Texas plant, appointed a supt. of the Bound Brook, N. J. plant. He will divide plant responsibilities with **T. F. Archer**, supt. Also at Bound Brook, **Vernon W. Schroeder** promoted to development assoc. in the Development Dept. With the Development Laboratories for 11 years, he has contributed to phonograph record molding and blow molding technology.

**Ronald L. Rasmussen** appointed asst. regional mgr. in the South Atlantic region. He will be located in the Moorestown, N. J. office.

**Joseph F. Rocky** asst. dir of development at the Bound Brook Development Laboratories, and **Ernest F. Turner**, area supv.—polystyrene at the Marietta, Ohio plant, named **Alfred P. Sloan Fellows** in exec. development at **Massachusetts Institute of Technology.**

**Owens-Illinois Glass Co.: Anthony J. Scalora** named chief of plastics R & D, General Research Dept.

**Lloyd T. Moore** named sales mgr. of **Libbey Plastics Inc.**, Lake City, Pa., formerly a part of **Keystone Brass Works**, which was purchased by O-I last Nov. He will devote full time to development of the company's melamine dinnerware products, and the possibility of making other plastic products. **Nathaniel Reyburn** named plastic engineer, responsible for engineering phases of Libbey Plastics' development.

**General Tire & Rubber Co., Bolta Products Div.: William D. Lippmann**, formerly supt. of Textileather's vinyl fabrics mfg. operations, named gen. mgr. of the Div., and **Charles L. Becker Jr.**, former distributor sales mgr., appointed gen. sales mgr. **William F. Murphy** promoted to works mgr. in charge of all production.

**B. F. Goodrich Chemical Co.; Antone Vittone Jr.** named gen mgr. of plants with responsibility for production facilities, product improvement and cost control. He is succeeded by **Dr. R. J. Wolf** as dir. of development, who will be responsible for operations of the development center at Avon Lake, Ohio.

**Dr. Benjamin M. G. Zwicker** appointed dir., of planning, with responsibility for project analysis, new products planning, patents, etc., for the firm.

**Du Pont Co.** has reorganized the R & D div. of the Polychemicals Dept. **Dr. William E. Grigsby** is dir. of pioneering research, **William A. Franta**, dir. of plastics R & D. **Dr. Donald M. Smith** heads a new ventures section, and **Dr. William F. Gresham** heads exploratory synthetic work, now part of the new unit.

**Malcolm M. (Mac) Taylor**, N. Y. dist. mgr. of plastics sales, retired after 45 years in the industry. He is succeeded as dist. mgr. by **Reuben Jeffrey Jr.**, former asst. dist. mgr.

**Allied Chemical Corp., Plastics & Coal Chemicals Div.: Whiting N. Shepard** appointed mgr. of Plaskon molding compound sales; **Eugene B. Hilker** named sales rep. in the Detroit, Mich. area; **Edward A. Jeffreys Jr.** in the southeastern U. S.; and **John F. Nelson**, Chicago, Ill. area.

**Hercules Powder Co.: E. F. Jennings Jr.**, formerly plant mgr. at Parlin, N. J., named plant mgr. of the polypropylene plant now under construction at Lake Charles, La. The new facility will have a capacity of 100 million lb. a year, and the first 50-million-lb. unit is expected to be in operation in early 1961.

**J. G. Copeland Jr.** promoted from asst. plant mgr. to plant mgr. at Parlin, N. J. He is succeeded by **F. N. Bent**, who was previously tech. asst. to the dir. of operations at the Cellulose Products Dept. **R. J. Bechtel**, who held supervisory posts in various company plants and has been at the Parlin plant since 1945, named tech. asst. to dir. of operations.

**Monsanto Chemical Co.—Plastics Div.**, Springfield, Mass.: **George W. Ingle**, section leader for polystyrene, promoted to asst. research dir. of a newly formed section responsible for polymer properties and standards. **Costas H. Basdekis**, former sr. group leader, promoted to asst. research dir. for polystyrene. **Dr. O. Paul Cohen**, former section leader, now asst. research dir. for polyvinyl chloride. **Dr. Manuel F. Drumm**, section leader for foam and film activities, named asst. research dir. in charge of plastics processing. **Q. A. Trementozzi**, promoted from section leader to asst. research dir. for fundamental and exploratory polymer activities, and **Leo P. Paradis**, to group leader of a newly formed polystyrene product development group. **Robert L. Bilton** rejoined Monsanto after serving in the U. S. Army, as a member of the marketing dept., and **Andrew Nemeth Jr.** joined the engineering dept. of the Plastics Div.

At Texas City, Texas, **Dr. Herbert D. Grove**, former sr. engineering supv., appointed engineering mgr. in the development section, and **Howard W. Martin** appointed engineering supv. in the engineering dept.

**Filon Plastics Corp.**, Hawthorne, Calif., mfr. of fibrous glass reinforced plastic panels, appointed **John K. Townsend** chief engineer, and **Chester E. Sanford** plant engineer.

**Wecolite Co. Inc.**, 552 W. 53 St., New York, N. Y., is the new corporate name of **Wecolite Co.**, mfr. of plastic housewares, whose assets have been purchased from **Henry Wechsler**, retired pres., by his son, **Abraham Wechsler**, the new pres., and **Morton Bucharest**, new exec. v-p.

**Olin Mathieson Chemical Corp.** has moved its general sales offices and New York-New England sales offices for film operations of the Packaging Div. from 655 Madison Ave. to 460 Park Ave., New York, N. Y. **Arthur T. Safford** named to the newly created position of dir. of marketing for the company.

**S. P. I., Thermoplastics Pipe Div.: George H. Reed**, mgr., plastics and chemicals, **American Hard Rubber Co., Div. Amerace Corp.**, elected chrmn. **John Lainson**, pres. of **Western Plastics Corp.**, Hastings, Neb., elected v-chrmn. **George C. Anderson**, mgr. for product development, **National Tube Div., U. S. Steel Corp.**, elected chrmn. of the **Plastic Pipe Research Council.**

**Specialty Resins Co. Inc.**, Lynwood, Calif. suppliers of resins for the plastics and paint industries, appointed **Philip Kaufman** asst. chief engineer. **Dr. Walter Brooks** and **Dr. Robert N. Johnson** named senior development chemists.

**A. O. Mayer Inc.**, mfr. of vinyl attache cases, briefcases, and portfolios, moved its plant and general offices to Bush Terminal, Brooklyn, N. Y. The new location provides 20,000 sq. ft. of plant space.

**Toscony Inc.**, New York, N. Y. producer of plastic fabrics, has opened a foreign operations headquarters in Duisburg, Germany. **H. Stauder**, former v-p of the foreign dept. in N.Y., is exec. v-p of **(To page 210)**

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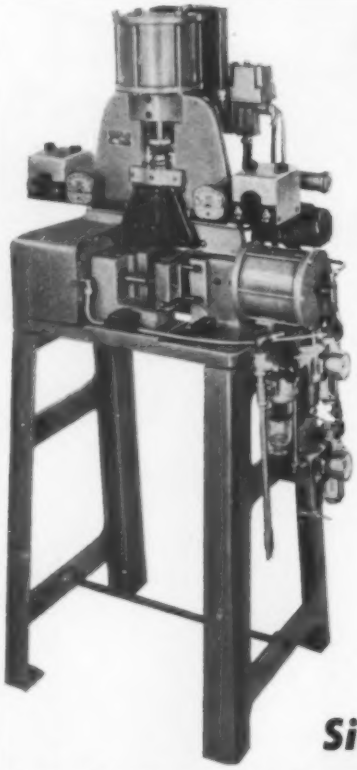

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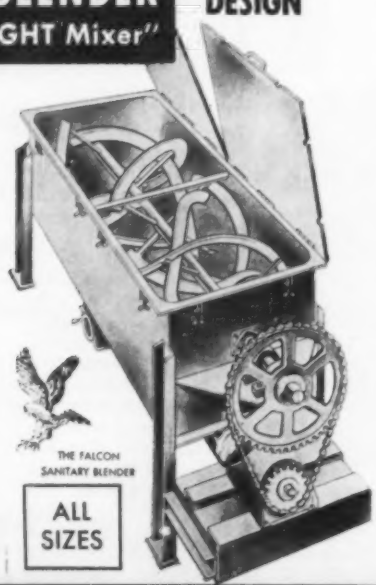


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## COMPANIES...PEOPLE

*(From page 208)*

the new foreign office. He is succeeded in the New York office by **F. Jaeger,** formely v-p in charge of production at Toscony's Passaic, N. J. plant.

**ESB-Reeves Corp.,** Glenside, Pa., elected the following officials: **E. J. Dwyer,** chrmn. of the board; **J. E. Reeves,** v-chrmn.; **D. N. Smith,** pres.; **Dr. V. L. Erlich, B. R. Prince, Dr. H. J. Strauss, and J. H. Wyatt,** v-p's. Dr. Strauss was also reappointed gen. mgr. of the company, which manufactures microporous plastics.

**Loma Industries Inc.,** Fort Worth, Texas: **Jack Bloch,** formerly with Foster Grant Co. Inc., appointed dir. of product design and development. **Clifford C. Freund** named sales mgr., custom products div. **R. V. Vosburgh,** formerly of Imco Container Corp., named a v-p and head of sales, blow molded div., will locate at the company's Kansas City, Mo. national sales headquarters.

**Crawford & Russell Inc.** has consolidated its exec. offices, engineering, and construction depts. at 7 Market St., Stamford, Conn. The firm designs and builds plants for producing polymers, plastics, synthetic rubbers, monomers, and organic chemicals.

**Richardson Co.,** Melrose Park, Ill.: **A. E. Wolfinger,** formerly New York-New Jersey branch mgr., now asst. sales mgr., Plastics Div. He is succeeded by **E. G. Whalen,** former field sales engineer. **K. D. Rhoads** appointed branch mgr. of the newly-established Philadelphia, Pa. office.

**Kordite Co.,** Macedon, N. Y., appointed **Robert D. Fletcher** and **Charles V. Trawick** as dist. sales mgrs., Industrial Div.

**Spaulding Fibre Co. Inc.,** Tonawanda, N. Y. mfr. of high-pressure, industrial laminates, appointed **Edward C. Leitz,** former asst. marketing mgr., dir. of sales administration; and **John E. Miner,** former dir. of liaison engineering, dir. of sales promotion.

**The Borden Chemical Co., Div of The Borden Co.: Edward F. Wezowicz** and **Gilbert L. Hembree** appointed tech. sales reps. for the Polyco-Monomer Dept.

**Extrudo Film Corp.,** polyethylene film extruder, moved its main office from Long Island City, N. Y., to new and larger quarters at 1841 Broadway, New York, N. Y.

**Harold W. Lenheiser,** former sr. engineer for the Rawsonville plastics operation of the Ford Motor Co., appointed exec. sales **(To page 212)**

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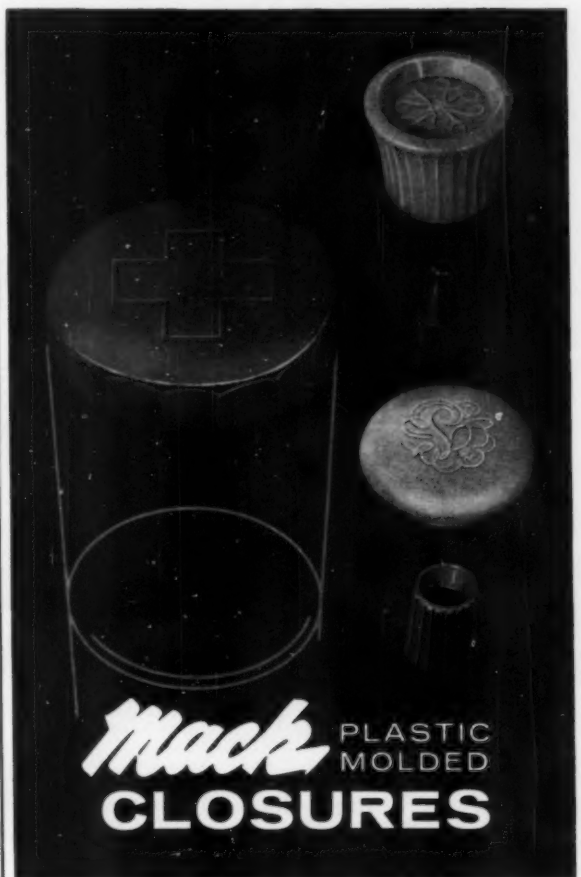


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**MACK MOLDING COMPANY • INC**

WAYNE, NEW JERSEY

*Serving the Packaging Industry Since 1920*

Other plants located in Arlington, Vermont and Waterloo, Quebec, Can.

for **PLASTICS**...specify the **PROVEN** temperature instrumentation–by **WEST**

- Complete selection of Controllers to suit Individual Requirements in Extrusion, Injection Molding, Blow Molding, Vacuum Forming and Heat Sealing.
- Compact, solid state, free from *vacuum* tube-problems, minimum supervision or maintenance. Specify on Original Equipment or purchase directly.

*Gardsman* by WEST

**MODEL JP** series provides *proportioning* heater control.

**MODEL JPT-2** integrates control of *both* heating *and* cooling for frictional heat in extrusion.

**MODEL JSB** series provides *stepless* heater control within *extremely close* tolerance; especially appropriate for extrusion die or injection nozzle control.

**THERMOCOUPLES**—complete selection of standard Thermocouples—including melt, bayonet, compression types preferred in working plastics—or send us your specifications on specials.

*Ask your West representative (see Yellow Pages) or write direct for Bulletins JP, JT, JSB and Thermocouple Data Book.*

WEST *Instrument* CORPORATION
SALES OFFICES IN PRINCIPAL CITIES
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British Subsidiary:
WEST INSTRUMENT LTD.,
52 Regent St., Brighton 1, Sussex
Represented in Canada by Davis Automatic Controls, Ltd

*the trend is to WEST*

## COMPANIES...PEOPLE

(*From page 210*)

engineer for **Detroit Plastic Products Co.**, Mt. Clemens, Mich., on assignment to the Ford Co.

**Joseph W. Selden**, former gen. mgr. of the Chemical div., **Minnesota Mining & Mfg. Co.**, elected divisional v-p.

**Sterling Extruder Corp.** moved from 1112 Baltimore Ave. to 1537 W. Elizabeth Ave., Linden, N. J.

**Dr. Herschel H. Cudd** named pres. of **AviSun Corp.**, a jointly-owned affiliate of **American Viscose Corp.** and **Sun Oil Co.** AviSun Corp., formed in Feb. 1959, manufactures polypropylene resin, film, and fiber.

**Arthur Johnson**, formerly with General Electric and Mica Insulator, now sales engineer for **New England Tape Co.**, div of **United-Carr Fastener Corp.**, Hudson, Mass. To oldtimers, Mr. Johnson will be remembered as a plastics rep. in the Navy's Bureau of Ordnance during World War II.

New England Tape manufactures a line of extruded plastics including nylon, vinyl, polyethylene, etc.

**Karl T. Kraner** appointed marketing mgr. for **Kessler Chemical Co. Inc.**, Philadelphia, Pa. mfr. of plasticizers and organic surface active agents.

**Lawrence N. Holden Jr.** named product mgr. in the Industrial Chemicals Div. of **Pittsburgh Chemical Co.**, subsidiary of **Pittsburgh Coke & Chemical Co.** He will be responsible for marketing of phthalocyanine pigments, maleic anhydride, and fumaric acid.

**Harry E. Roche**, mgr. of the Port Arthur, Texas plant of **Koppers Plastics Div., Koppers Co. Inc.**, retired after 26 years of service. He is succeeded by **Alfred M. Miller Jr.**, formerly asst. mgr. at that location.

**William M. Riegel**, previously eastern sales mgr. for packaging materials, promoted to mgr. of merchant and industrial sales for the Specialty Products Div., **Riegel Paper Corp.**, mfr. of specialty papers, (release, impregnated, PE-coated, etc.).

**H. Martin Allard** elected v-p—plastics of **Improved Machinery Inc.**, Nashua, N. H. He has been with the company since 1945 as chief engineer of plastic molding machinery.

**Samuel Ringel** appointed marketing mgr., epoxy products div. of **Joseph Waldman & Sons**, Irvington, N. J.

**Howard K. Norris**, formerly production mgr., named marketing mgr. of the mechanical goods div., **U. S. Rubber Co.**, and assumes marketing su-

pervision of power transmission products, plastics, automotive products, etc. He is succeeded by **Henry W. Willard** as production mgr.

**David Radford, Ekco Plastics Ltd.,** Southend-on-Sea, Essex, England, elected chrmn. of the **British Plastics Federation** in London, England, succeeding **N. B. Punfield, Punfield & Barstow Ltd.**

**Robert E. Huffman,** sales engineer, transferred from Chicago, Ill. to San Francisco, Calif. for **W. S. Shamban & Co.,** Culver City, Calif. designer and mfr. of specialized plastics.

**Noble Sherwood** appointed tech. dir., Reinforced Plastics Div., **A. O. Smith Corp.,** Milwaukee, Wis.

**William S. Vaughn,** formerly v-p and gen. mgr., elected pres. of **Eastman Kodak Co.** Prior to returning to Rochester, N. Y. in Jan. 1959, he was pres. of **Eastman Chemical Products Inc.** Mr. Vaughn succeeds **Albert K. Chapman,** now chrmn. of the board.

**Howard A. Smith** promoted from New England dist. to national sales mgr. for **Emerson & Cuming Inc.,** Canton, Mass., mfr. of foams and encapsulating materials for the electronic industry.

**Murray Neipris** appointed plant supt., **The Blane Corp.,** Canton, Mass., supplier of vinyl and polyethylene compounds and color concentrates.

**Robert A. Grief** named sales rep. for **Conneaut Rubber & Plastics Co.,** Conneaut, Ohio custom plastic compounders and extruders.

**Howard Thompson** joined **Lunn Laminates Inc.,** reinforced plastic molders, Huntington Station, N. Y., as project engineer.

**Alan Sheppard** appointed Plastics Div. salesman, Los Angeles area, for **Coast Mfg. & Supply Co.,** Livermore, Calif., supplier of polyesters, epoxies and other materials for the reinforced plastics industry.

**Dr. James R. Dudley,** v-p, research and development, **The Richardson Co.,** Melrose Park, Ill., elected pres. of **The Commercial Chemical Development Assn.**

**William M. Marshall,** formerly tech. service rep. for Mobay Chemical Co., named mgr. of urethane foam production, Plastics Div. of **Nopco Chemical Co.**

**H. J. Paulus,** formerly mgr. of building product sales, appointed mgr. of reinforcement marketing, fibrous glass div. of **Pittsburgh Plate Glass Co.,** Pittsburgh, Pa.

**Don S. Catterson** appointed to newly created position of mgr., Adhesives Div. of **Chemical Process Co.,** Redwood City, Calif. mfr. of wood working adhesives and ion exchange and polyester resins.

**Irving B. Polhemus** elected v-p and gen. mgr., **Acme Resin Corp.,** producer of phenolic materials and diallyl phthalate molding compounds.

**Richard Blais** named applications engineer, **Photocircuits Corp.,** Glen Cove, N. Y. The company produces printed circuits.

**E. E. Kotkin** resigned as pres. of **Plastic Process Co.,** Los Angeles, Calif., div. of **Monadnock Mills,** custom extruders. He has headed the organization since it began operations in 1939.

**Howard V. Henderson,** regional mgr. for **Ren Plastics Inc.,** Lansing, Mich. specialists in epoxy compounding, transferred to Detroit office to cover Michigan and Ontario territory.

**John W. Berthold** appointed chief engineer, **American Insulator Corp.,** New Freedom, Pa. custom molder.

**R. M. Paulsen** named dir. of research for the Plastic Bottle and Tube Div., **Continental Can Co.**

**John J. Reed,** previously mgr.—market development, National Aniline Div., Allied Chemical Corp., appointed exec. v-p, **Casavan Industries Inc.,** Paterson, N. J. producer of foamed plastics used for insulation and in curtain-wall construction.

**William G. Cole Jr.** promoted from gen. mgr. to corporate v-p of **Ferro Corp.'s** Fiber Glass Div.

**Philip H. McLaughlin** appointed gen. sales mgr., **Century Chemical Corp.,** New York, N. Y. mfr. of pigments, dyes, and chemical intermediates.

**Fredrick P. Bassett** named advertising mgr., **Chicago Molded Products Corp.,** mfr. of custom molded plastic components, Campco sheet, and molded melamine dinnerware.

**W. F. Christopher,** formerly mgr.—market development of General Electric Co.'s chemical materials dept., appointed to newly-created post of dir. of marketing for **Hooker Chemical Corp.,** New York, N. Y.

**Dr. Leo S. Burnett** named tech. dir., **Food Machinery & Chemical Corp.'s** Dapon dept. Dapon diallyl phthalate resin is used in plastic laminates and in compression molding; particularly of electronic components.

**B. Parker Middleton** named sales mgr., **Dayton Dayflex Plastics Co.,** div. of **Dayco Corp.** He will be responsible for **(To page 215)**


Comet "LAB-MASTER"
DRAPE AND VACUUM FORMING MACHINE
FOR ALL THERMO FORMING TECHNIQUES

- Plug assist
- Vacuum Snap-back
- Blow molding
- Air cushion and billow forming
- Mechanical Forming
- Pressure Forming
- Automatic cycling
- Adjustable clamp frame
- Draw to 10"
- Mold area 14" x 20"
- Fabricates all thermoplastic from .001 to .187

Other STANDARD Comet Machines: LAB-VAC, Three Station ROTARY, COMET "TWIN", "STAR" Thermo Forming Press, "MERCURY" Continuous Vacuum Forming and Packaging Machine, Automatic Skin-Pak and slitting unit.

Write for bulletin M-7

COMET INDUSTRIES • FRANKLIN PARK, ILL., U.S.A.
PROGRESS IN PLASTICS

FROM
START
TO
FINISH
YOU'RE
IN
SKILLED
HANDS
AT
COMMERCIAL
DECAL
Skilled hands help you design your patterns. Skilled hands produce the almost flawless melamine foil. Skilled hands help your technical people use them most efficiently. Skilled hands and trained minds produce in volume, deliver on time when you do business with Commercial Decal. For details, write or phone today: Commercial Decal, Mount Vernon, New York.
America's most experienced producers of melamine foils. Special patterns may be commissioned.

Plastic materials are best prepared for maximum production and highest quality when dried and pre-heated with Whitlock Dehumidifying Dryers.

- Desert dry air (below —20° F dewpoint) under pressure from a positive displacement blower is drawn through the material insuring an ideal processing condition.
- Variable temperature control (125° F to 250° F or higher) insures material preheating to optimum temperature for fastest production, best quality products, and minimum power requirements.

Whitlock Dehumidifying Dryer features:

- Closed air system, positive displacement blower.
- Automatic desiccant regeneration.
- Air spreader at hopper throat.
- Quick-access filter chamber.
- Easy installation.

*Write for full details . . .* Whitlock

60-E

**WHITLOCK ASSOCIATES, INC.**

**21655 Coolidge Highway • Oak Park 37, Michigan**

## COMPANIES...PEOPLE

(From page 213)

merchandising and sales of Dayflex and Nylaflex hose for vacuum cleaners, hairdryers, appliances, etc.

**Dr. Charles A. Heiberger,** formerly with **Food Machinery & Chemical Corp.,** joined **Air Reduction Co. Inc., Central Research Laboratories,** Murray Hill, N. J., as asst. dir. in charge of polymer development.

**Donald B. Begley** assigned to exec. sales—isocyanates, for **Allied Chemical's National Aniline Div.**

**John K. Widmer** appointed sales mgr., custom sales, **Kurz-Kasch Inc.,** Dayton, Ohio plastic molder.

**Guy J. Robichaud,** formerly chief chemist at Acton Rubber Ltd., formed his own business as tech. consultant to the plastic and rubber industries and is located at Granby, Quebec, Canada.

**Stefan P. Boran** appointed dir. of styling research for **The Dobeckmun Co.,** div. of **The Dow Chemical Co.**

**William E. Pearson** promoted to gen. mgr. of **Molded Fiber Glass Boat Co.,** Union City, Pa. He is succeeded as gen. sales mgr. by **Edward M. Kohtz.**

**James D. Stewart** appointed mgr. of metal and plastics quality control inspection at **Goodyear Aircraft Corp.,** Akron, Ohio.

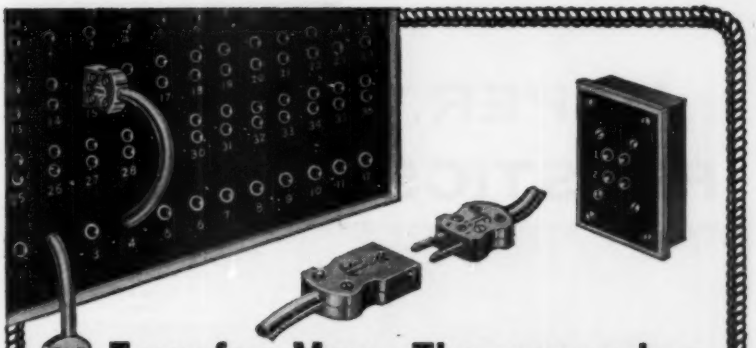
**Maurice Winger Jr.** appointed gen. mgr., **William Brand-Rex Div.** of **American Enka Corp.,** Concord, Mass. mfr. of plastic-covered wire and cable, plastic extrusions, and ultra-high frequency cast plastics for microwave applications.

### New reps.

**Foss Mfg. Co.,** Twin Falls, Idaho, appointed rep. for **Marblette Corp.,** Long Island City, N. Y., in Idaho, Nevada, Utah, and Wyoming, for plastics materials including epoxy resins for casting, laminating, electrical insulation, plastics tooling, adhesive uses, etc. . . .

**Central Chemical Corp.,** with headquarters in Hagerstown, Md., and regional offices in Butler, Everett, Gettysburg, Milton, and Glen Rock, Pa.; Lockwood and Andover, Ohio; Harrisonburg, Va.; and Bridgeville, Del.; appointed regional distributor for **Du Pont** polyethylene film in its five-state marketing area. . . .

**Standard Insulation Co., Inc., East Rutherford, N. J.,** appointed **C. P. Waggoner Sales Co. Inc.,** 301 S. E. 14th St., Grand Prairie, Texas; and **D & O Engineering Co., Inc.,** 1610 E. Harry St., Wichita, Kan., as new reps. for its **(To page 216)**

**Transfer Many Thermocouples**

**With T-E Quick-Coupling Connectors and Panels**

**Connector Panels** T-E has one for your exact needs. These panels provide flexible, centralized control in transferring any number of thermocouples to indicating, multipoint recording and controlling pyrometers. Ideal for patch panel use, they are available in many compact shapes and sizes — with interchangeable plugs and jacks in I-C, C-C, and C-A. A panel for 48 thermocouples and 16 pyrometers measures only 13¼" x 7⅞". Polarity markings and screw-fastened connections make wiring easy.

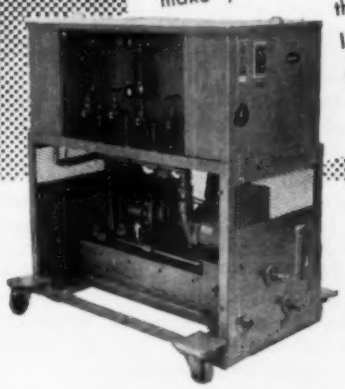
**Quick-Coupling Connectors** These connectors permit fast, easy making and breaking of thermocouple circuits. Durable construction guarantees long, dependable usage. Polarized and mechanically interchangeable, all plugs and jacks are of standard matched thermocouple materials. Spring-loaded contacts with long wiping surfaces provide firm but easily broken connections.

*Write for Bulletin 23 — 17*

**Thermo Electric Co., Inc.**
SADDLE BROOK, NEW JERSEY
In Canada—THERMO ELECTRIC (Canada) Ltd., Brampton, Ont.

IMS **INJECTION MOLD CHILLERS**

Are you getting full benefit from your high speed injection machines? There's no use paying for horse power and speed if your molds do not keep pace! Investigate IMS Mold Chillers today! They'll make your new injection machines pay for themselves in cycles saved — let you cash in on injection machine speeds you have already paid for —



**THREE STOCK MODELS**

2 - 6 oz. Presses (W-150) .. $1945.00
4-12 oz. Presses (W-300) .. $2642.10
8-24 oz. Presses (W-500) .. $3645.00

For 220 volt, 60 cycle, 3 phase only.

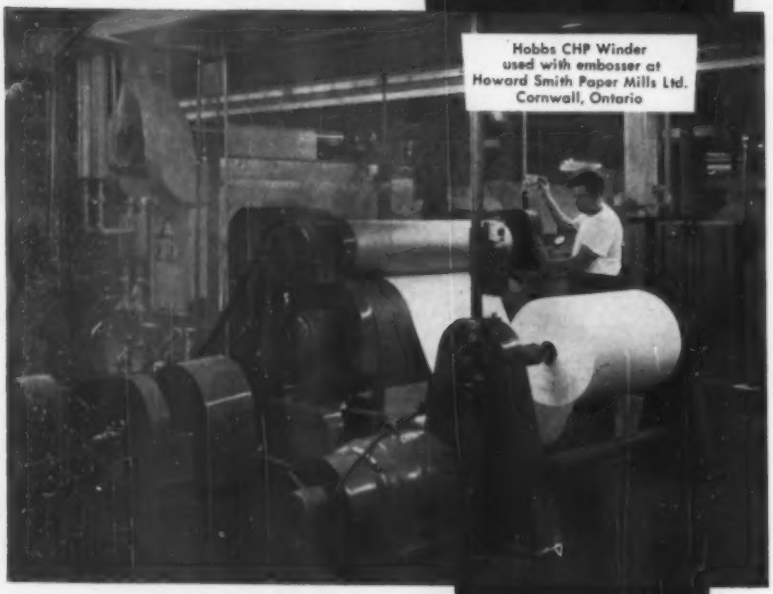
**Order One Now!**

The ONLY Mold Chiller designed exclusively for injection work
Burst proof coils - Adjustable temperature range 90° to 20°F.

**INJECTION MOLDERS SUPPLY CO.**
3514 LEE ROAD WYoming 1-1424 CLEVELAND 20, OHIO

PAPER
PLASTICS

More For Your Winding Money!



Hobbs CHP Winder used with embosser at Howard Smith Paper Mills Ltd. Cornwall, Ontario

RUBBER
TEXTILES

Whatever You Wind!

**HOBBS Delivers More for Your Winding Money**

**REPORT ON HOWARD SMITH MILLS INSTALLATION:**

Hobbs CHP unit winds exceptionally broad range of material thicknesses, requiring complete flexibility of winding tension control . . . handles widths up to 52″ maximum, winds from 4″ O. D. cores to 42″ O. D. rolls at speeds up to 1000 f.p.m. A typical Hobbs job — engineered for high performance on wide variety of widths and weights, different speeds and diameters!

WINDERS
•
SLITTERS
•
HAND & POWER SHEARS
•
AUTOMATIC CUTTERS
•
DIE PRESSES

Hobbs builds winding machines in entirety to meet your requirements best. We manufacture all types of web winding equipment with all types winding drives, stands and tension controls (electrical, mechanical, hydraulic, etc.) Whatever you wind, Hobbs helps you get *more for your winding money.*

Ask for NEW 1960 "Principles and Practices of MODERN WINDING". A Standard Industry Manual. Use your checklist to analyze your *true* winding requirements.

HOBBS Manufacturing Company
25G Salisbury Street, Worcester 5, Mass.
EST. 1903

*Representatives in Irvington, N. J., Chicago, Cleveland, Louisville, Greenville, S. C., Los Angeles, Toronto and other principal cities.*

101-0


## COMPANIES...PEOPLE

(*From page 215*)

Stanpreg pre-impregnated materials in the reinforced plastic, aircraft, and electrical industries. . . .

**Epoxy Products,** div. of **Joseph Waldman & Sons,** Irvington, N. J., appointed the following sales-engineering reps.: **E. J. Foley Assocs.,** 3840 N. Jokake Dr., Scottsdale, Ariz.; **The National Co.,** 70 Marion St., Seattle, Wash.; **Design & Sales Engineers,** 7603 Forsyth Blvd., St. Louis, Mo.; and **R. Topal Co.,** 120 Ocean Pkwy., Brooklyn, N. Y. . . .

**Chatfield Paper Corp.,** 3265 Colerain Ave., Cincinnati, Ohio, named rep. by **Midwest Plastic Products Co.,** Chicago Heights, Ill., for its line of extruded thermoplastic sheet stock. . . . **Millholland-Conrad Inc.,** Indianapolis, Ind., appointed by **Whitlock Assocs. Inc.,** mfr. of pneumatic and vacuum conveyors and dehumidifying dryers. . . . **H. I. Thompson Fiber Glass Co., Blackwood's Div.,** Los Angeles, Calif., appointed exclusive distributor by **The Carwin Co.,** N. Haven, Conn., for its infusible urethane systems and certain urethane coatings. . . .

**R. A. Roosevelt Co.,** La Mirada, Calif., appointed West Coast rep. for the Industrial Div., **Daffin Mfg. Co.,** Lancaster, Pa., for its materials processing and handling equipment including precision batch blenders, pelleting machinery, grinding and pulverizing mills, and pneumatic conveying systems. . . . **Brass & Copper Supply Co. Inc.,** 501 W. 23 St., Baltimore, Md., appointed a distributor by **U. S. Rubber Co.** for the plastic products of the mechanical goods div. . . .

**The Hainge Co. Inc.,** 3323 Mercer St., Houston, Texas, appointed rep. in the Southwest for **F. J. Stokes Corp.,** Philadelphia, Pa., and will provide technical and sales engineering service for equipment built by Stokes Vacuum and Press Divs. The Vacuum Div. line includes systems for high-temperature sintering, vacuum coating, impregnation, etc.; the Press Div. builds automatic plastics molding equipment, and Stokes' newly-introduced plastics bag-making machinery and blow-molding equipment. . . . **Raymond M. Burke** appointed supv. of market research for **Heyden Newport Chemical Corp.** He joined Newport after previous association with U. S. Borax & Chemical Corp. and General Foods.

### Correction

"Thermoformed relief maps" (MPI, June 1960, p. 166): Maps are vacuum formed by Aero Service Corp., using equipment from Auto-Vac Div., National Cleveland Corp., Bridgeport, Conn. Sealing equipment is made by Sealomatic Electronics Corp., Brooklyn, N. Y.—End

. . . but no output. Try again . . . press button . . . No joy—only hubbleplop. Why? Bit No. BZ661-664a/43*n* was taken off for cleaning and never seen again!

Operator not to blame: machine out of date—too complicated. Too many bits! Bits to wear out. Bits to lose. Bits in the way of cleaning and adjusting. Contrast with DANIELS. Very clever. DANIELS machines have *no* odd bits. Quicker to build. Easier to operate. Less to go wrong. So DANIELS sell more machines. Ingenious? But *you* benefit most! *Better* design, *high-strength* construction, *precision* engineering, *Ease of operation*.

*Write immediately for Daniels "Hubbleplop-avoider" literature*

World's finest, latest and fastest Thermo-setting presses, Vacuum-forming machines.

## DANIELS OF STROUD

T.H. & J. Daniels Ltd ( M.P. ) · Stroud · Gloucestershire England · Established 1840 · Telephone Stroud 661-664 Telex 43-43 Daniels · Stroud · England.

# CLASSIFIED ADVERTISEMENTS

**EMPLOYMENT • BUSINESS OPPORTUNITIES • USED OR RESALE EQUIPMENT**

## Machinery and Equipment For Sale

**FOR SALE:** Ovens, Grinders, Powder Mixers, Injection Molding Machine 1 oz. to 60 ozs. never used and used. Two-head Bottle Blowing Machine. Acme Machinery & Mfg. Co., Inc., 20 South Broadway, Yonkers, N.Y. YOnkers 5-0900. 102 Grove Street, Worcester, Mass., PLeasant 7-7747.

---

**FOR SALE:** Baker-Perkins #15-UUMM 100 gal. Dispersion blade mixer, jkt., 100 HP, cored blades, comp. cover. Stainless reactors or resin Kettles: 3500, 2200, 1900, 1300, 1000, 750, 500, 350 gal., jktd. and agit. Bakers-Perkins dbl. arm mixers: 200, 100, 50 gal. capacity, steel or stainless. Perry Equipment Corp., 1429 N. 6th St., Phila. 22, Pa.

---

**FOR SALE:** 4 compression molding presses, 470, 200, 150 and 100 tons; 2 extruders, 2½" MPM, electrically heated, 4½" Royle, oil heated; 2 Cumberland 7" stair step dicers; 1 Readco 25 gallon stainless steel vacuum double arm mixer; 2 Ball & Jewell rotary cutters, models #1 and #1½; 1—22" x 60" plastics mill, 150 HP. Chemical & Process Machinery Corp., 52 9th Street, Brooklyn 15, N. Y. HY 9-7200.

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**FOR SALE:** Van Dorn model H 250 injection molding machine. Machine equal to new. Approx. 1956 model used only on occasion. Reply Box 6587, Modern Plastics.

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**MOST MODERN PACKAGING AND PROCESSING MACHINERY:** Available at great savings. Robinson Stainless Steel Double Arm Mixer for dry and viscous materials. Baker Perkins, W. & P. and Day Double Arm Steam Jacketed Heavy Duty Mixers—25, 50, 75, 100, 150 and 200 gal. capacities. Devine 650 gal. Jacketed Double Spiral Mixer. Day 2½ gal. MDA Mogul D.A. Vac Experimental Mixer. Fitzpatrick Models D, K-7 and K-8 Stainless Steel Comminuters. Werner & Pfleiderer 3,000 gal. and 3,500 gal. Jacketed Double Arm Mixers. Stokes Models R, RB-2 and DD2 and Eureka Tablet Machines. Colton 2RP, 3RP, 3B, 5½ T Tablet Machines. Mikro Pulverizers, Models 1SH, 2TH, 3TH and 4TH. Day, Robinson 50 to 10,000 lbs. Dry Powder Mixers, Jacketed and Unjacketed. Also wood and enamel. Day Imperial 75 gal. Double Arm Mixer, Sigma, Dispersion Blades. Package Machinery, Hayssen, Scandia, Wrap King, Campbell, Miller Wrappers. Standard Knapp, A-B-C, Ferguson Carton Sealers. Union Standard Equipment Company, 318 Lafayette Street, New York 12, N. Y. Phone: CAnal 6-5334.

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**TESTERS:** Impact, Tension, Fatigue and Compression. 1 Farrel 16 x 36 Mill, 30 HP motor & drive. Baker Perkins 150 gal, 2 arm, 40 HP; 100 gal, 2 arm, 50 HP, S.S. jacketed, vacuum, hyd tilt. Hammermills. Jaw Crusher. Calender 6 Roll 5 x 12. Ball Mills. Powder Blenders 10,000 & 7,000 lbs. Machinecraft Corp., 800 Wilson Ave., Newark 5, New Jersey. MI 2-7634.

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**28" TURNER PLASTIC** Preform Machine, 1951; Size & Cap. 4' 3" dia. x 5½' High Plennum Chamber with built in Baffles. Shute type complete with motors and controls. Excel. Ferro Equipment Co., 5454 Bellevue, Detroit 11, Mich. WAlnut 5-2230.

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**FOR SALE:** Vinyl Plastisol Products manufacturing equipment. Includes 24' tunnel oven and drives, tooling, metering pump, 7½ HP air compressor, vacuum pump and other related equipment. Burner is 1 million B.T.U. capacity. $17,000. Will consider partnership. Model Molders, Wadsworth, Ohio.

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**FOR SALE:** MPM 3½" wire covering Extruder. New ¾" Plastic Extruder. Other sizes up to 6". Seco 6" x 12" and 8" x 16", 2—Roll Mills and Calenders, and other sizes up to 60". W.S. 300 Ton Semi-autom. Transfer Molding Press. Watson-Stillman 240 ton, ten 24" x 56" platens. Baldwin-South. 150 ton downstroke 48" x 40" platens. Stokes Standard 50 & 150 ton Semi-automatic. French oil 120 ton self-contained. 120 ton upstroke, 29" x 21" platens, 10" stroke. 60 ton Farquhar 50" x 50" platens, 30" stroke. 50 ton Birdsboro 24" x 20" platens. 30 ton Birdsboro 21" x 14" platens. Hydraulic Pumps and accumulators. 4—60" Spreader Heads with XP motors. Despatch elect. Heated Ovens and other types. New ¾ oz. Bench Model Injection Molding Machines. Van Dorn 1 oz. and 2 oz., other sizes to 100 oz. capacity. Baker-Perkins and Day Jacketed Mixers. Plastic Grinders. Calenders. Stokes RD3 Rotary-Preform Tablet Machine, also single punch ⅛" to 4". Send for listings. We buy your surplus machinery. Stein Equipment Company, 107—8th Street, Brooklyn 15, New York.

---

**FOR SALE:** 1—Banbury "B" Mixer; 1—Farrel Birmingham 8" x 16" Chrome Plated 2-Roll Mill; 1—Baker-Perkins 100 gal. Sigma blade Mixer; 1—Baker Perkins size 16 TRM 150 gal. double arm Vacuum Mixer; 1—No. 1 Ball & Jewell Rotary Cutter; 2—Mikro Pulverizers, S. S. Bantam, #1 SH; 6—Stokes Model DD2, DS3, D3, and B2 Rotary Preform Presses, partial listing; we purchase your surplus. Brill Equipment Co., 35-55 Jabez St., Newark 5, N. J. Tel: Market 3-7420.

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**INJECTION MACHINES:** Two (2)—9 oz. HPM 1953. Two (2)—10D12 REEDS 1953

All in excellent operating condition and can be seen under power. Moonglow, 106-10 Dunkirk Street, St. Albans 12, New York. JA 3-3300.

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**CHECK THESE SPRING VALUES:** 600 Ton Adamson Multi-opening Hydraulic Press. 26" dia. chrome-plated ram, slab side construction. Press contains nine 42" x 42" platens. New 1951. Stokes Model "R" and Colton Model 4½ T, single punch Tablet Presses. Individually motor driven. NRM 1½" Electrically Heated Plastic Extruder. Complete with wheelco panel board and Vari-speed drive. Ball & Jewell #1½ Rotary Scrap Cutter. Direct coupled to 25 HP motor. Extra knives and screens. 75 Ton Baldwin-Southwark Transfer Molding Press, completely self-contained with all operating controls. 50 Ton Standard and 75 Ton Watson-Stillman Automatic Molding Presses. Fully self-contained, complete with timers and push buttons. Cumberland #1½ Rotary Scrap Cutter with 10 HP motor. 2½ oz. Van Dorn Fully Automatic Injection Molding Machine. Also in stock: Van Dorn 1 oz. lever-operated Injection Molding Machine, Van Dorn 2 oz. Semi-automatic Injection Molding Machine, new 1955, NRM 2½", Royle 3¼", Hartig 3¼", and Adamson 6" Extruders. Also a complete line of Blenders, Mixers, Scrap Cutters, etc., for the Plastic and Rubber Industries. What do you need? What do you want? We will Finance. Johnson Machinery Company, 90 Elizabeth Avenue, Elizabeth, New Jersey. ELizabeth 5-2300.

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**MUST LIQUIDATE EQUIPMENT PRICE IS NO OBJECT!** Modern F-B 2 Roll Mills, 14" x 30"; 16" x 42"; 22" x 60"; Roll Calender 22" x 58" Latex Pouring Curing Line Truck Dryers; 30" and 100" Adamson Vulcanizers 6' x 16' Baker Perkins Mixers to 300 Gal. Banbury Lab Size B Mixer 2 Stokes Vacuum Impregnators Stokes Aut. Molding Presses Southwark-Dunning-Boschert French Oil Mill Hydr. Presses Extruders: Royale No. 1; Allen 2" MPM 4½" and MPM 1½". Utility Stock Cutter 9" wide. Send for Complete List. First Machinery Corp., 209-10th St., Bklyn. 15, N.Y. ST-8-4672; Cable "Effemey."

---

**THERMOTRIM** Die-Cutting Press 36 x 53. Good condition. Ullman Co., 319 McKibbin St., Bklyn 6, N. Y. HY 7-3700.

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**FOR SALE:** Injection molding machines. 8 oz. Reed Prentice with straight bore nylon cylinder. 12 oz. Reed Prentice Model 10D12. 48 oz. HPM with Vickers Pumps. Low pressure mold protection. May be seen in operation at American Molded Products Co., 2727 W. Chicago Avenue Chicago 22, Illinois.

---

**FOR SALE:** 1 hyd. press, 4 cylinder 20 ton each, 15" opening, 12" x 12" die space each unit. Height 79" length 60" width 26", 5" stroke, used only a few hrs. $1950.00 Western Tool & Die, 5407 27th Ave. N. E. Seattle, Washington.

## Machinery Wanted

**WANTED TO BUY:** Used injection molding machines, oven, granulators. One machine or complete plant. Acme Machinery & Mfg. Co., Inc., 20 South Broadway, Yonkers, N.Y. YOnkers 5-0900. 102 Grove Street, Worcester, Mass. PLeasant 7-7747.

## Materials Wanted

**GET THE TOP MONEY FOR PLASTIC SCRAP:** Now paying top prices for all thermoplastic scrap. Wanted: polystyrene, cellulose, acetate, vinyl, polyethylene, butyrate, acrylic, nylon. All types and forms including rejects and obsolete molding powders. Fast action wherever you are located. WRITE, WIRE, TODAY! Reply Box 6578, Modern Plastics.

---

**FIBERGLASS MAT WASTE WANTED:** any quantity of small pieces of any shape or size. Must be clean and free of molding resin. Molex Products Company, 9515 Southview Ave., Brookfield, Ill.

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**WE ARE IN THE MARKET** for all types of thermoplastic scrap; also surplus or obsolete lots of reprocessed or virgin molding powders. D. Linder Plastics, Inc., 1825 Raspberry St., Erie, Pa. Phone GLendale 4-8146.

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**PLASTIC SCRAP WANTED:** Sell us your mid-year surplus inventories of plastic scrap or surplus molding powders. Acetate, Acrylic, Styrene, Polyethylene, Butyrate, etc. in any form. Write, Wire or Phone Collect: Phillip Shuman & Sons, 571 Howard Street, Buffalo 6, New York. tele: MAdison 3111.

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**WANTED:** Plastic of all kinds—virgin, reground, lumps, sheet and reject parts. Highest prices paid for Styrene, Polyethylene, Acetate, Nylon, Vinyl, etc. We can also supply virgin & reground materials at tremendous savings. Address your inquiries to: Gold-Mark Plastics Compounds, Inc., 4-05 26th Ave., Long Island City 2, N.Y. RAvenswood 1-0880.

## Materials for Sale

**FOR SALE:** 5,000 pounds jet black E/C pellets; 10,000 pounds m/e Nylon 101; repr. and regr. cycolac, various colors. All at low prices. Box 6609, Modern Plastics.

## Molds for Sale

**MOLDS (INJECTION) FOR SALE:** All in excellent condition, ready for molding housewares, containers and covers. Some are brand new (duplicate) some are discontinued items. Will fit 8 to 12 oz. machines. Priced to move. Rogers Plastic Corp., W. Warren, Mass. HEmlock 6-7744.

*(Continued on page 220)*

# ONLY $359.60 ROUND TRIP TO HOLLAND'S PLASTIC EXPOSITION

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*(Continued from page 218)*

## Help Wanted

**TECHNICAL SERVICE** engineer: Should have experience in the use of polyester resins in the production of reinforced plastics. This position involves considerable customer contact in addition to some work in our laboratories. This company is well established in the synthetic resin field and is the chemical subsidiary of the H. H. Robertson Co. and offers a generous line of fringe benefits. Address replies to: Mr. K. A. Schafer, Freeman Chemical Corp., 211 E. Main Street, Port Washington, Wisconsin.

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**SALESMAN:** Experienced in virgin and reprocessed plastics to eventually take over as Sales Manager for a reprocesser. Excellent opportunity for the right man. Salary open. Operate generally in the Metropolitan New York-New Jersey area at present. Reply Box 6577, Modern Plastics.

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**PLASTIC-EXTRUSION ENGINEERS:** Initiative, incentive and some experience in processing and extrusion techniques preferred. New openings in technical department created by expansion program of a large, reputable polyethylene film producer. Salary commensurate with ability. Send resume to: Plastic Horizons, Inc., 1 Erie St., Paterson, N.J.

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**POLYMER CHEMIST**—Position in polymer development for Chemist or Chemical Engineer. Work in both bench scale and pilot plant on various petroleum derived polymers. Two to five years experience in polymer development or degree work in polymer chemistry. Send resume to Technical Department, Cosden Petroleum Corporation, Box 1311, Big Spring, Texas.

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**WANTED:** Young man with industrial engineering experience to work as assistant to plastics plant superintendent in plant layout, time studies, and personnel utilization. Salary open. Plant located in Virginia. Replies held in confidence. Reply Box 6581.

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**ADHESIVE SALES:** Outstanding opportunity in adhesive sales division of a large multi-plant Midwest manufacturer. Opening for a college graduate between 30 and 35 with proven sales ability and 2 to 5 years experience in adhesives or allied sales field. Established territory with growth potential. Excellent salary, year end bonus, car and expenses. Send detailed resume including salary requirements. All replies strictly confidential. Reply Box 6582, Modern Plastics.

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**FILM LAMINATION EXPERT:** Wanted to operate and head-up a laminating and embossing department for a specialty manufacturer located near Hartford, Conn. Applicant must be experienced in handling film laminations and adhesives. Research and development experience helpful. Salary open, write in detail to Box 6583, Modern Plastics.

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**EXTRUDER SALES ENGINEERS:** Experienced in selling Extruders and Blow Molding Equipment. Unlimited potential. Replies confidential, should include experience, education and salary requirements. Write to C. S. Gilbert, Sales Manager, Modern Plastic Machinery Corporation, 64 Lakeview Avenue, Clifton, New Jersey.

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**PLASTIC PLANT SUPERINTENDENT:** Administrator to take full charge of large extrusion plant owned by top AAA corp located in Midwest. Must have strong leadership abilities & proven capabilities of solving everyday production problems. Write full details of experience, personal data and salary requirement. All answers kept in strictest confidence. Our employees know of this ad. Reply Box 6584, Modern Plastics.

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**INDUSTRIAL MFGRS. REP. WANTED** Industrial Manufacturers Rep. now covering Ill., Wisc., Ind., and Michigan wanted by well established, progressive, nationally known mfg. of flexible and rigid plastics; extruded & fabricated products. Commission basis. Reply Box 6585 Modern Plastics giving full details.

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**ENGINEER:** Position open for agressive man age 30 to 45. Modern progressive firm in the Mid-west with well-rounded line of Plastic products including an unusually successful proprietary item that insures our continuous profitable operations. Must be capable of setting up production on injection presses from 8 oz. to 90 oz; as well as 350 ton compression presses. Should also have thorough understanding of chemical and physical properties of the polystyrenes, butyrates, acrylics, etc. Reply in confidence giving complete resume of past employment, education and salary requirements. Reply Box 6590, Modern Plastics.

---

**FLORIDA LOCATION:** Plant manager wanted with plenty mechanical know-how in sheet extrusion and vacuum forming. If you have ability, dynamic leadership, and want to earn a good living and have fun doing it, contact us in confidence. We are a publicly owned small company, stock has doubled in nine months. Ownership possibilities through performance. Reply Box 6586, Modern Plastics.

---

**PLANT MANAGER BLOW MOLDING:** Proprietary injection molder desires to diversify and set up separate blow molding operation. Interested in man to take full charge of operation, must be fully capable all phases including mold design, personnel, purchasing, quality and production control. Opportunity for great advancement. Send full resume. Reply Box 6588, Modern Plastics.

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**MOLD DESIGNER:** Plastic molder needs man experienced in mold design. Send complete resume and salary expected to Tube Turns Plastics, 2929 Magazine Street, Louisville 11, Kentucky. Replies will be held in strictest confidence.

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**ENGINEER:** Plastic molding, top grade engineer to prepare estimates, quotations, tool layouts, etc. from blueprints. Must be experienced. Excellent opportunity. Submit resumé stating qualifications and salary requirement. Reply Box 6591, Modern Plastics.

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**POLYSTYRENE POLYMERIZATION:** A new enterprise in the polymerization of Polystyrene molding and extrusion compounds, including impact types, desires to hire an experienced chemist or engineer in this field. Opportunity for excellent advancement—complete responsibility for project both production and research. An unusual situation for the right person. Reply stating education and experience. All replies will be kept in strictest confidence. Thanking you for your co-operation. Reply Box 6597, Modern Plastics.

---

**SALES ENGINEER:** Successful sales organization requires service of young college grad to train in sales of laminated phenolics, injection and compression molded. Some plastics experience helpful—Chicago area. Send resume. Reply Box 6593, Modern Plastics.

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**PLASTICS SALESMAN:** Reprocessor and distributor of thermoplastics raw materials. New York area, some traveling. Salary basis. Send resume to Box 6608, Modern Plastics.

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**PROMINENT POLYPROPYLENE MANUFACTURER** Has openings in several U. S. territories for well established Selling Agents catering to injection molders and extruders. Reply giving qualifications and lines currently handled to Box 6600, Modern Plastics.

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**SALES SERVICE ENGINEER** for specialty coatings manufacturer. Top opportunity for a technical analyst who may now be a project engineer or lab engineer working on industrial coating applications or development. Has the potential to give shirt-sleeve service to a wide range of industries. Will have the support of a top-notch lab and development team. Write T. E. Hayden, Bee Chemical Co., 12933 S. Stony Island Ave., Chicago 33, Ill.

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**COATINGS CHEMIST:** Key position in growing laboratory of Midwest specialty coatings manufacturer. Must be creative, self-starter, with 2 to 4 years wide-range experience in developing paint formulations. Will report to Chief Chemist. Reply Box 6606, Modern Plastics.

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**HEAT SEALING PRODUCTION MAN.** Full charge heat sealing. Cutting floor management and purchasing of vinyl. Plant location Mid-town, New York City. Box 6601, Modern Plastics.

---

**EXTRUSION ENGINEER:** Large nationally known Eastern Manufacturer has opening for experienced, aggressive man who has full knowledge of pipe and tubing extrusion, also must have design experience. Background of injection molding, blow molding and/or wire coating helpful. Submit full resume and expected salary. All replies confidential. Reply Box 6603, Modern Plastics.

---

**MEDIUM SIZED** successful manufacturing firm in Midwest desires man with experience in techniques and design in Blow Molding. Excellent opportunity for right man to grow with an expanding company entering this new field. Reply Box 6602, Modern Plastics.

---

**PRODUCTION ENGINEER**—challenging position for experienced production supervisor in the field of Polystrip cable, laminates, and flexible etched circuits. Particularly desirable is experience with the hot laminating of 90% thermoplastic plastics materials & metals. Knowledge of screening, etching and finishing operations on laminates essential. 3-4 years as a supervisor of both hourly and salaried employees also desirable. Submit resume and salary requirements in strict confidence to: Dept B-3 Industrial Relations, **International Resistance Company**, 401 North Broad Street, Philadelphia 8, Pa.

---

**BLOW MOLDING OPPORTUNITY:** Newly formed company with solid know-how and financing is looking for a top salesman experienced in blow molding or injection molding to organize and implement sales program. This is a challenging career for the right man. We will consider only those applicants who present qualified industry backgrounds. Location—Greater New York. Write Box 6607, Modern Plastics.

---

**FIBERGLASS PLASTIC TOOLING AND** parts: Custom manufacturer of epoxy resin and polyester resin reinforced plastic tools and parts needs representatives in many states. Company's products are well received and name is well respected. A young industry with a very good future. Latrobe Plastic Company, 310 Unity Street, Latrobe, Pennsylvania.

---

**WANTED: MANUFACTURER'S** Representative. Experienced and well established custom molder and extruder in Cleveland area desires additional representation on industrial components and assemblies. Box 6610, Modern Plastics.

*(Continued on page 222)*

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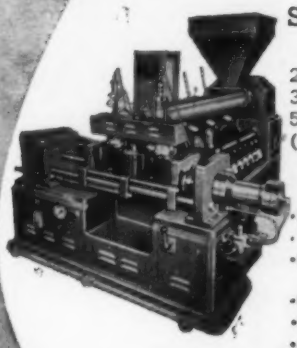
**Injection Molder!**
**Extruder!**



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**KATO SEISAKUSHO CO., LTD.**

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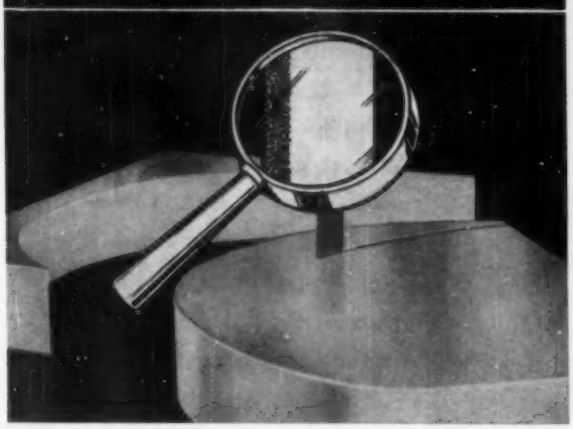

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*(Continued from page 220)*

## Situations Wanted

**PLASTICS ENGINEER**—14 years diversified plastics experience in development, technical service and production of FRP, filament winding, epoxy, phenolic and melamine laminates. Presently owner of own business. Salary area—$12,500. Desire responsible position with progressive plastics firm. Any location. Reply Box 6576, Modern Plastics.

**CHAIN STORE SALES:** representative with office-showroom on Fifth Ave. New York City, desires additional housewares line from established and reliable manufacturer. Presently selling to all major variety chains, supermarket chains, and large premium accounts. Reply Box 6579, Modern Plastics.

**PLASTICS ENGINEER,** background in product development, equipment design, plant layout, production methods. Heavy experience with polyethylene, blown film, extrusion coating, casting and rigid sheeting. Capable of managing entire operation including administrative duties. Willing to work here or abroad. Reply Box 6592, Modern Plastics.

**COMPETENT MOLD MAKER,** plastic and die-cast. Past experience also on metal-dies., jigs, fixtures, gages, arc and acetylene welding and machine repair. Able to draw oven designs. Supervisory experience. Most all jobbing shop experience. 43 yrs. of age, married, seeks permanent position with usual fringe benefits in established factory outside of any metropolitan area. Reply Box 6580, Modern Plastics.

**CHEMIST AND ENGINEER:** M. Ch. E. 1951 licensed engineer 16 yrs. broad, responsible experience, R & D, process design & development, pilot plant, prod. management, plant and proj. engineering. Plastics, polymers, injection and rotational molding, paints, rubber, adhesives & organic chemicals. Publications. Wants position where capability and versatility count. N. Y. City $10,000 min. Reply Box 6605, Modern Plastics.

## Miscellaneous

**BLOW MOLDING OPERATION WANTED** Injection molder currently manufacturing a line of proprietary items. Is interested in purchasing outright medium size blow molding plant. Cash available. Principles and management would have option to remain. Reply Box 6589, Modern Plastics.

**FOR EXPORT:** Button dies and miscellaneous molding equipment available for export. Write Merit Plastics, 30 Lincoln Place, Lynnbrook, N.Y.

**SUCCESSFUL SALES ORGANIZATION** Available for Eporters to Benelux. Here's a rare opportunity for someone seeking a distribution set-up in the Benelux area! For 12 years, with great success, our firm has represented one of the largest U.S. producers of plastic materials. Only because they are setting up their own organization, we will lose one of our major products. We are seeking new plastic and chemical lines. Excellent references. Offices in Brussels and Rotterdam. Write IMEXIN S.A., 5, Av. de Broqueville, 15, Brussels, Belgium.

**WELL-ESTABLISHED** West German Injection-Molder wishes to quote on high-volume nylon products up to three (3) ounces. Excellent mold making facilities on premises and well located in the heart of the plastic mold manufacturing industry. Modern plant insures prompt delivery. Representative for engineering residing in New York City. Reply Box 6596, Modern Plastics.

**SEASONED INJECTION MOLDING ENGINEER** & Executive with outstanding record of success, presently in complete charge of big plant interested in purchasing an interest in Injection Molding plant or in purchase of small plant in New York Metropolitan area. Can bring custom molding business with him. Reply Box 6598, Modern Plastics.

**BUSINESS FOR SALE:** With $75,000 Tax Loss. Vacuum forming plant—completely equipped. 1958 Auto-Vac, EQA 30 x 50 with roll feed and assist. 1959 Lab-Vac with assist, 60" Abbott, 1959 Taber Thermoformer, also Creaser, much miscellaneous equipment. Proprietary molds and finished goods inventory. Substantial raw material inventory. Several O.E.M. repeat contracts. Located Michigan. Can be moved. Appraised $48,000. Make offer. Reply Box 6604, Modern Plastics.

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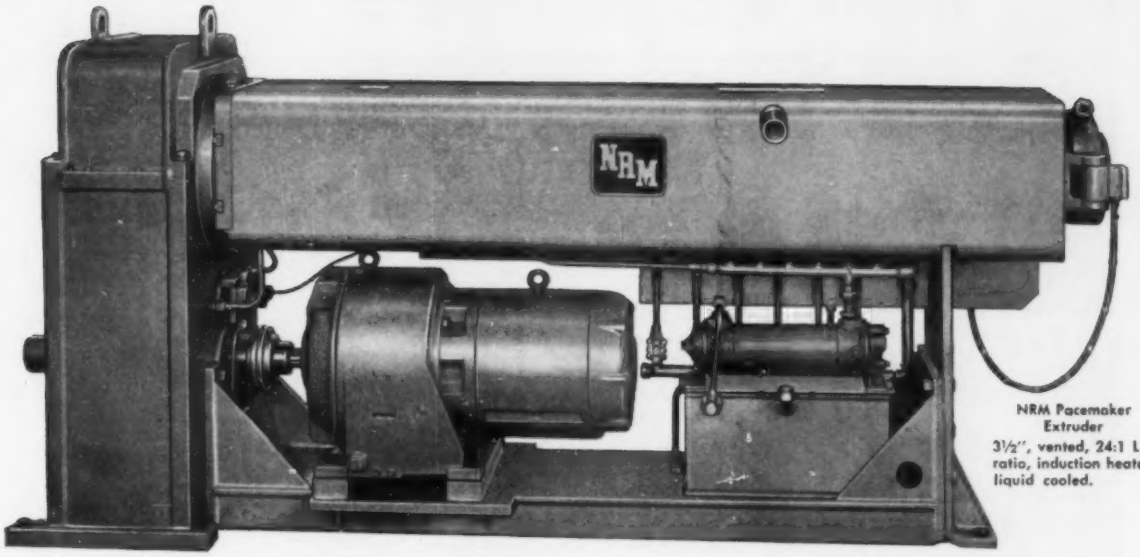


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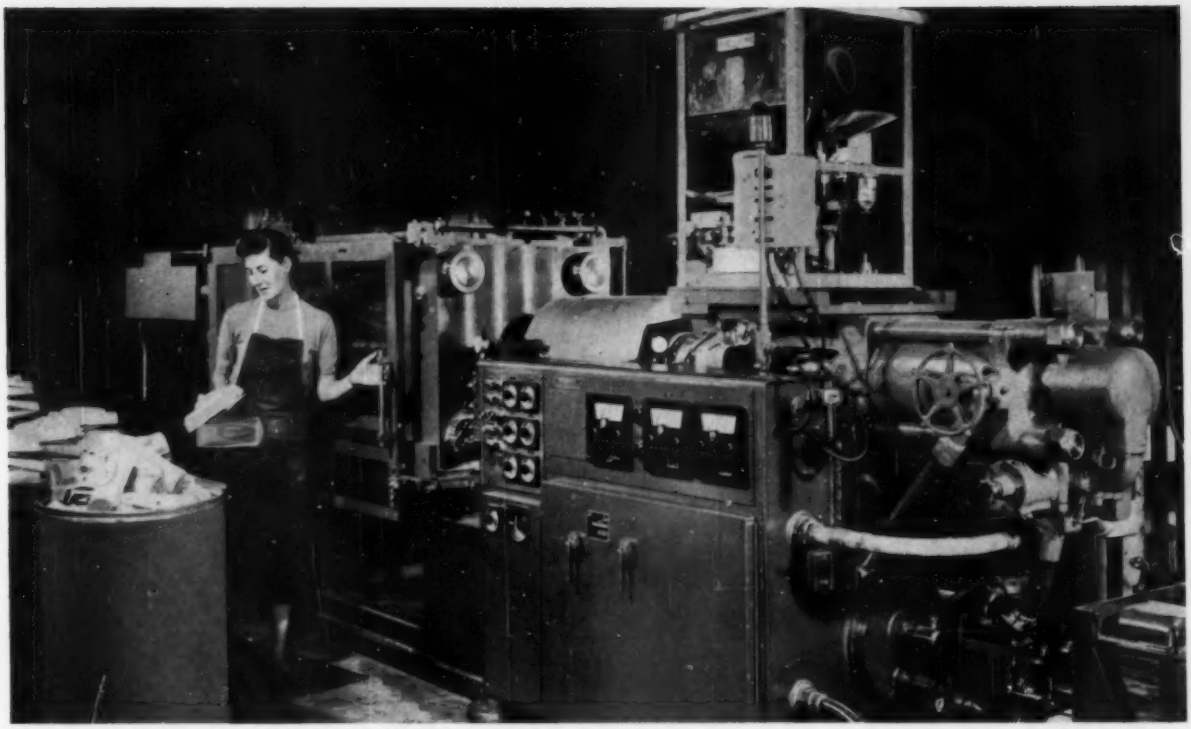

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TECHNICAL PAPERS FOR INDUSTRY

# EDITORIAL

## Custom processors do too much gratis

At the Annual S.P.I. Conference in Miami Beach in May, a very worthwhile panel session discussed "Custom Versus Captive Molding—What Is Profitability and Future?" On the panel were heads of custom molding companies, heads of captive molding plants, a machinery consultant, a mold maker, and a materials supplier representative.

Well-worn arguments, pro and con, were paraded by the panel. The captive molders' costing systems do not permit comparative cost studies with those of custom molders. The custom molders' battle for business with captive plant management and with other custom molders is a cost battle being frequently fought in fog or darkness. Even the price at which different companies can acquire plant rehabilitation capital and working capital comes into the picture. On the part of the captive molder, there was discussion as to when he would prefer to send the job out, and when repetitive performance would permit automation. Also brought up were matters of quality control, deliveries, and transportation.

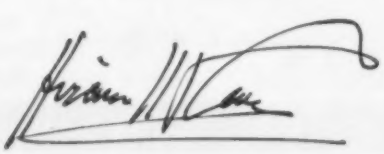
Regardless of the trend toward integration and captivity, there will always be a place for custom enterprise in plastics processing. And for some custom processors, there will be a much bigger place than there is at present.

We offer the following suggestions:

1. Merge horizontally, either in terms of talent and plant, or in terms of geography, or both. Since many end products today are made up of components, each made from a different material and by a different processing method, this would give the custom processor's salesmen or representatives a broader scope of enterprise with which to serve.

2. Specialize on the newer, stronger, and more heat and chemical resistant materials. The designer and the end-user invariably want the newest materials because they offer some hope of giving a superior product.

3. This is a major key to the future of custom processing. The same process of costing and pricing must not be used for blueprint quotations that would be used where creative engineering, design talent, and processing know-how will be required from the custom processor. On non-blueprint jobs, he must be paid for consultation and engineering study over and above the part cost, as eventually delivered to the end-user.

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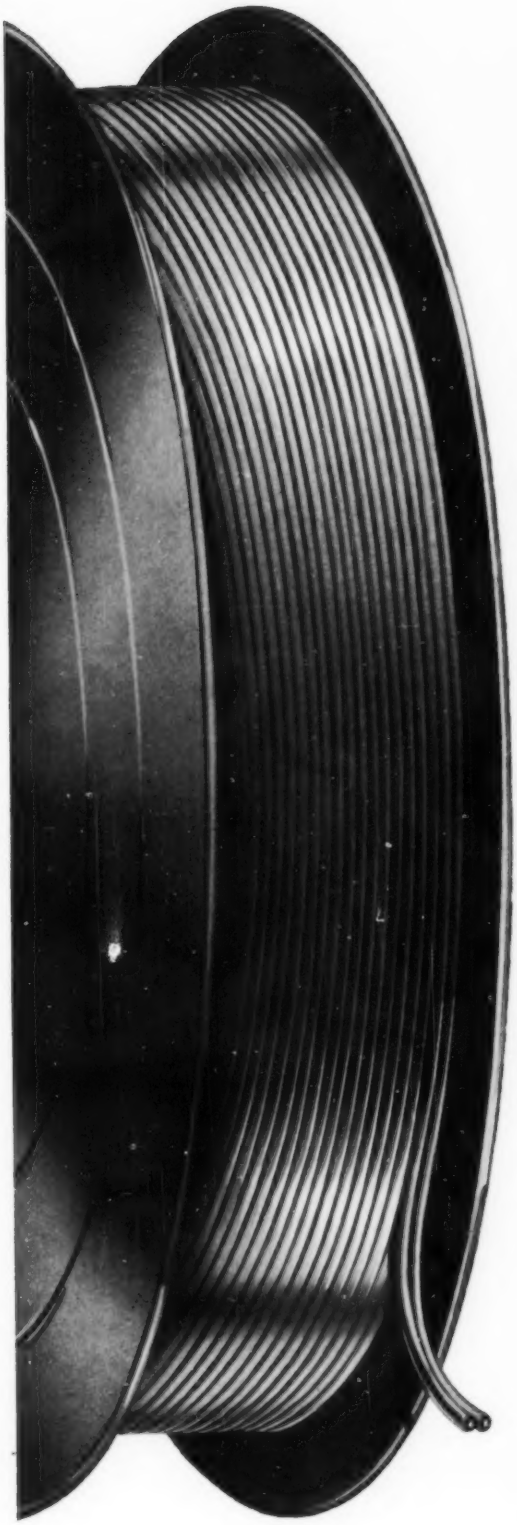

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